The sanitary aspect of the sewage question / by James Adams.

THE SANITARY ASPECT OF THE SEWAGE QUESTION.

BY
JAMES ADAMS, M.D.

GLASGOW:
JAMES MACLEHOSE, 61 ST VINCENT STREET,
BOOKSELLER TO THE UNIVERSITY, AND TO THE FACULTY OF PHYSICIANS AND SURGEONS.
1868.

PREFACE.

My "Notes of an Argument in Reply" were prepared for a temporary use, and no consideration was further from my mind at the time than any thought of after-publication. They formed part of a discussion which commenced, and, in my opinion, should have terminated, within a medical circle. The discussion originated thus:—

A communication on "The Sanitary Aspect of the Sewage Question, with Remarks on the Scheme of Messrs Bateman & Bazalgette for the Purification of the River," was read before the Medico-Chirurgical Society of Glasgow (2d October, 1868) by Andrew Fergus, M.D. At this meeting an unusually large number of stranger visitors was present, many of whom were of the non-professional public. An abstract of the communication was furnished to the newspapers of the following day, and was therefore widely circulated. The arena was thus speedily changed, so as to include the general public. The communication itself contained much strong expression of opinion on disputed points, and the conclusions were in antagonism to my own conviction, and, as I think, to those of nearly all medical men who have been

accustomed to give consideration to questions of public health. They were, moreover, of a kind calculated to give rise to a mischievous panic, if not vigorously opposed and confuted. Therefore, at the next meeting of the Society (16th October, 1868) I read a counter argument.

Some misconception of the nature of my views appeared in the public prints, and I was alleged to have expressed opinions that I have repudiated. For these, and such other reasons as are stated in a letter to a newspaper, a reprint of which will be found at the end of the Appendix, I resolved to print my "Notes of an Argument in Reply," in their *ipsissima verba*, as delivered.

J. A.

Glasgow, 62 Cambridge Street,
Nov. 26, 1868.

THE SANITARY ASPECT

OF

THE SEWAGE QUESTION.

(Read before the Medico-Chirurgical Society of Glasgow, 16th October, 1868.)

THE sanitary aspect of the Sewage question in its relation to Glasgow, and to the state of the river Clyde, is a subject upon which it is almost as difficult to speak as to remain silent. For while, on the one hand, we have admittedly the necessity of dealing with a nuisance existing at our doors of a character that revolts our senses, and discredits our position as members of a civilised community, we have, on the other hand, to make our choice of a remedy amid the distracting din of a multitude of conflicting counsellors.

It is a subject on which Dr Fergus has evidently bestowed much time and attention; and we have to thank him for bringing his views before us on a matter of vital importance in a manner so interesting, and accompanied with illustrations which convey so clearly their exact nature. He has thus made it easy for those who may comment on his argument to select the grounds on which they may agree or on which they differ.

He possesses the great advantage over many who may differ from him, that his mind is made up—he has no faint, cold-hearted doubtings—he is clear and decided—both the disease and what will mend it are patent to his sight, and he expresses his opinions with all the emphasis of earnest conviction.

In venturing, however, to dispute his conclusions, and to think that these are not fully warranted by such data as he has brought before us, I may premise that I also have given the subject serious consideration. On various occasions, extending back for many years, I have had opportunities of assisting in the labours, and of witnessing the results of the labours, of several investigators. I have had occasion to consider and to advise with parties who have engaged commercially in schemes of commerce that are closely bound up in the question; and I am at present, and for a considerable time past have been, associated with a colleague of high scientific eminence, in a special and very extended investigation of the effects of certain sewage matters on the pollution of rivers, during which investigation it has been necessary, among other tests, to conduct many hundreds of physiological experiments upon living animals. According to my light, I therefore feel entitled to speak with no uncertain voice.

I am sorry I have been unable to follow Dr Fergus to his conclusions. I think they are not only not warranted by his data, but that much of what he has advanced should have led him to results altogether opposite. To my apprehension, his whole argument resolves itself into a strenuous denunciation of the modern water-closet system. I hope that I state rightly his conclusions as being to the following effect:—

1*st*. That water-closets are opposed to Revelation.

2*nd*. That they are opposed to Nature, by causing an extravagant waste of matters necessary for agriculture—in short, a robbery of the soil.

3*rd*. That they are the *sole* cause of the polluted state of the river, by their conveying human excreta into the river through the medium of the sewers.

4*th*. That human excreta fills the sewers with noxious gases, which penetrate into our dwelling-houses despite the best contrived mechanical appliances in the form of traps.

5*th*. That even assuming that, by Messrs Bateman & Bazalgette's plan, the sewage of Glasgow could be fairly conveyed away—an assumption which is, however, opposed to his convictions, owing to various engineering defects which he holds to exist in their scheme—there would still, he says, be no improvement in the sanitary state of the city, owing to the noxious gases referred to as generated in the sewers.

6*th*, *and lastly*. That the use of dry privies, conjoined with one or other of the several methods for deodorizing human excreta, of which he has exhibited illustrations, would reinstate the river in a fair state of purity, and be preferable in every way to the water-closet system.

Allowing for its compression, I believe the foregoing to be a fair summary of Dr Fergus' opinion.

With regard to the argument founded upon alleged Revelation, I have simply to observe, that the children of Israel, camping in the desert, following for years a nomadic life, and unacquainted, or at least unprovided with sewers and a distributed water supply—very badly off, indeed, on some occasions for water—were rightly instructed by Moses to go outside the camp. This injunction was most suitable for the time and circumstances; but I know of no Revelation which should elevate this temporary regulation into a rule of faith, or a principle in sanitary science. Indeed, if Dr Fergus had not referred to the argument more than once, I would scarcely think that the name and authority of Moses had been imported into the question with a seriously intended application.

His next argument, that the human excreta of large towns is a material of great value to the agriculturist, is one of much importance, and, beyond cavil, merits the utmost attention of social economists. But the question which agitates Glasgow at the present moment—the question that Dr Fergus has asked us to specially consider—is, not the needs of the country farmer, but the sanitary necessities of the Glasgow citizen. We are not at present discussing the best means of conserving, as a source of revenue, the waste products of this large city, but how to deliver ourselves from their immediate hurtful influence on our comfort and on our health. That is the question, and that the recognised necessity. The commercial side of the problem is merely incidental, and, at a long distance, altogether secondary.

I willingly concede that the offensive state of the river is due in large part to the human excreta that is conveyed into it through the medium of the sewers.

And this brings us to the argument on which Dr Fergus devotes his chief force, viz., the production of noxious gases in the sewers.

I must go a little fully into this part of his argument, for, besides its intrinsic importance as regards the chemistry of the subject, Dr Fergus has very properly told us that, while we can take some tolerably fair precautions in the avoidance of unwholesome food and drink, we are almost helpless in dealing with the gaseous matters which may contaminate the air we breathe, and, in illustration, he has shown us how we may exhibit ourselves in an amusing state of apprehension, with fingers on nostrils, rushing past the vapours exhaling from a gulley hole, all the while unconscious that the same vapours, although not visible, are, or may be, leaking into our dwelling-houses through imperfect fittings connecting them with the sewers.

Dr Fergus has told us how these vapours—or, as he in preference calls them, gases—are produced. He has told us,

and with unexceptionable accuracy, that the human individual excretes from the bowels and kidneys a definite quantity of solid and fluid matters of a putrescible nature —that this matter is passed from the water-closets into the sewers, where it undergoes decomposition—that certain poisonous gases result—that these gases find their way, *to some extent*, through all obstacles in the shape of traps, and so contaminate the atmosphere of our dwelling-houses, and originate gastric fever.

Dr Fergus has endeavoured to advance the reception of his views by exhibiting a Table, showing, by chemical analysis, what he calls the "Products of Sewage Matter," which he, further on, as a convertible term, names "sewer gases," and he has striven to impress our minds with a conception of the appalling amount of the gases enumerated in his Table, by telling us that these gases escape, as was proved in the analysis referred to, at the rate of from 1 to 1½ cubic inches per hour from a single gallon of sewage. No limit is given as to the time the gases continue to be evolved.

Now, I have very often had occasion to observe that an undue weight is attached to the names of chemical compounds when used in connection with sanitary questions, and that they often produce the same stupifying terrorism that is caused by the use of the names of the awful "boggies" who, in nursery tales, are ready to lay hold of naughty, wakeful children who are troublesome, and should be off to bed.

Let me not for a moment be misunderstood. I am not about to contend that the emanations of decomposing matters are innocent; that is, are not injurious to health. I do most fully recognise the evils which, under certain circumstances, may arise from continued and prolonged exposure to them, even when diluted, and I am well acquainted with the recorded experience of their effects when concentrated. But it is of the highest importance that the extent of the evil should be defined, as far as that is possible, and that our imaginations should be

protected from the effects of misty, or erroneous, or exaggerated statements.

With the view, therefore, of disabusing your minds of the impression that may have been made regarding the dimensions of this monster of the sewers, I will again summon him before us, examine his exact form and size—his body and limbs—and will try if I cannot again drive him back, with teeth and claws extracted, to his lurking den, whence, we are told, he makes his raiding excursions upon our domestic hearths. Without metaphor, I believe I shall have little difficulty in satisfying you that Dr Fergus has fallen into several serious errors, and, *all unconsciously*, has exaggerated the *import* of the Table he has laid before us.

This Table is professedly taken from Dr Letheby, Medical Officer of Health for the City of London, and author of an admirable "Report on the Subject of Sewage," &c.; and we are informed by Dr Fergus that it exhibits, according to Dr Letheby, the composition of the gases produced in the sewers. Now, I no sooner looked at the Table, and heard the statement, than I saw that some great fallacy or error was underlying the whole. It was quite evident to me, that neither Dr Letheby, nor any one accustomed to prepare tables of chemical analysis, could have issued such a Table, because the summations of the per centages exceeded a *centum*, and because I knew well that, unless under some circumstances altogether exceptional, there never was evolved from sewage matter so large a per centage of sulphuretted hydrogen. I turned accordingly to Dr Letheby's Report, and found that this Table has no place there, and that it must have been made up by Dr Fergus himself—or by some one in whose capacity he has too implicitly trusted—from data which he has altogether misapprehended.

Here are the simple facts: Dr Letheby took a gallon of London sewage, selected, as he specially informs us, *from one of the worst districts of London*. It contained the enormous

amount of 278.5 grains of dissolved and suspended matter. This he subjected to a *laboratory experiment*, excluding it carefully from the air, and continuing the experiment for a period of *nine weeks!* In this experiment he thoroughly exhausted, by fermentative decomposition, the entire putrescible matters, and the results were, *in part*, what Dr Fergus has shown —viz., the *formation—not the escape ready formed*—but the formation of carburetted hydrogen, carbonic acid, and nitrogen, in the proportions given. But instead of from 2 to 3 per cent. of sulphuretted hydrogen, there was only an 80-000th part—of ammonia there was only as much as could be recognised—that is, a trace; and there is not a word of sulphide of ammonium, or of a putrid organic vapour in connection with this experiment.

Where, therefore, did Dr Fergus get all the sulphuretted hydrogen shown in the Table? Not from this experiment, nor from this gallon of sewage, but from *four additional experiments* made upon *other four gallons of sewage* taken from various localities. And these experiments, moreover, were *of a totally different* character. In these Dr Letheby allowed all the suspended matter in the sewage to subside, and then he took the clear liquid and *boiled it*, with the usual result of evolving *all the gases* which were in solution. These gases, of course, were in totally different proportion and quantity from those obtained in the first experiment, and the sulphuretted hydrogen was not in the proportion of from 2 to 3 per cent., as stated erroneously in Dr Fergus' Table, but in the proportion of barely 1 to 3 per cent. You will understand, therefore, that we shall be exposed to the influence of this quantity of sulphuretted hydrogen only *when we boil our sewage, not otherwise.* But Dr Fergus has discarded all the other gases obtained in these four experiments, in which the sewage was boiled, and, selecting the sulphuretted hydrogen alone, given it place in the Table that shows the result of the other experiment in which sewage was *fermented.* I need scarcely say to

my present hearers that that sulphuretted hydrogen has no more right to occupy the place given to it in the Table than if it had been purchased from a drug-shop and poured among the other gases.

We have still to account for the ammonia, the sulphide of ammonium, and the putrid organic vapour; and I find that their production was a result obtained from still another set of experiments made, not upon the sewage itself, but upon vapours contained in the atmosphere of different sewers. These vapours Dr Letheby *condensed, or concentrated into a liquid*, and the analysis of this *concentrated* liquid has been also added to the Table, as forming part of the $1\frac{1}{2}$ cubic inches of gas that Dr Fergus tells us is evolved from a single gallon of ordinary sewage during a period not specified.

I hope I have made this matter sufficiently clear. Let it suffice that I tell you this Table laid before you by Dr Fergus is a mere jumble of pickings from three varied sets of investigations. In one set, Dr Letheby extracted certain of the *actual* matters contained and residing *in* the sewage; in another set, he *exhausted* the *potential* matters that could be *evolved out of* the sewage during its putrefaction, *when carried to the utmost extent;* and in the third, he *supplemented* results necessary to complete the inferences to which the others led. Let me put this in another form. In one set, he ascertained the gaseous products into which the sewage *could ultimately be resolved* under certain peculiar and *exceptional* conditions; and in another, he ascertained, by equally peculiar and *exceptional* means, the *actual matter* of which it was composed. Of course, I use the word "exceptional" with a restricted meaning that does not require explanation.

To return to the gases. What do you suppose was the quantity, after all, that was evolved from this gallon of very impure London sewage during the entire nine weeks under these *exceptional* conditions? Why, little more than one cubic foot of all the gases put together; and, instead of being

evolved at the rate of one and a-half cubic inches *per hour* for an indefinite period, they were evolved at the rate of 1·2, or barely one and a-*quarter* cubic inches per hour for *a limited period*. If the whole sewage of Glasgow was equally impure, and was subjected to the same exhaustive laboratory experiment—*i.e.*, *fermented*—the total amount would not be more than 434 cubic feet per hour—a quantity that could be shut up in a box little exceeding seven and a-half feet cube. As for the sulphuretted hydrogen contained in the worst specimen examined, the extreme total quantity was three cubic inches. Further, the total quantity *of all the gases* extracted from any one of the four specimens of sewage that were *boiled* was only from 32 to 76 cubic inches—not a twentieth part of a cubic foot for the whole gases put together.

Enough of this unlucky Table of "sewer gases." I assume that I have satisfied you that any gases that may find a road, through imperfect fittings, from the sewers into your dwellings are not the gases that were *boiled* out of the sewage, or *manufactured* under a bell-receiver in a laboratory experiment. Let us, therefore, go directly to the atmosphere itself of the sewers, and let us look at the gases just as they are generated and just as they are found in the sewers, and from this examination draw our own conclusions.

It is well known that the atmosphere of the sewers is able to support vigorous animal life. Witness the myriads of rats that have their *habitat* in the sewers—the workmen who make their livelihood by constructing, repairing, and cleansing sewers—and the numerous individuals whose special industry it is to prowl through the sewers grubbing up and searching for lost articles and other matters of which they make a profitable disposal. A knowledge of such facts, and a little reflection, should therefore make us chary in believing all we are told of the hurtful character of the gases evolved in sewers. Indeed, it will seem strange, even to many here, to be informed that the atmosphere of the sewers differs very

little from the atmosphere in its normal condition as regards its elementary constituents. Referring again to Dr Letheby—and I might quote other authorities, but I know none better—I will place before you a table for which he is responsible, showing the composition of the atmosphere of the City of London sewers, and of atmospheric air in its normal state, assuming, of course, both to be in a dry condition—*i.e.*, free of watery vapour:—

	Atmosphere.	Sewer Atmosphere.
Nitrogen, ...	78·959 ...	79·962
Oxygen, ...	21·000 ...	19·506
Carbonic Acid, ...	0·041 ...	0·532
Carburetted Hydrogen, ...	None ...	Traces
Ammonia, ...	Traces ...	Rather abundant
Sulphuretted Hydrogen, ...	None ...	Traces rarely exceeding a 60,000th part.

Analyses, giving results which may be held identical, have been made of the atmosphere of the sewers of Paris by M. Claubry and others, and in our own country by Dr R. D. Thomson, Dr Angus Smith, &c., and they show that, as regards known chemical substances, such as the gases so often referred to, there is but little difference.*

This, then, is the condition that obtains in the sewers of London and of Paris, where, in both places, there exist circumstances that favour, in a degree far beyond what can possibly affect Glasgow, the formation and the accumulation of vapours loading and contaminating the atmosphere with which the sewers are filled.

That the atmosphere of the Glasgow sewers is better than that of London or of Paris we are fairly entitled to assume, for numerous reasons. Thus, we know that air and water, in the degree that they come in contact with decaying matter, exert a great influence in modifying the putrefactive process. *The more air and the more water, the more potently the changes*

* See Appendix, Note 5.

are effected, and the less offensive are the products of decomposition. Now, the London sewage is diluted with water to the extent that there is furnished 30 gallons of sewage matter per head per day, while that of Glasgow amounts to 70 gallons per head per day—*a difference so enormous as to make any comparison altogether inapplicable*, and, consequently, to show the gross fallacy of drawing an inference from one state of things, and applying it to a condition where the circumstances are altogether different. And here I may inform you, in passing, that a gallon of average Glasgow sewage contains about 50 grs. per gallon of dissolved and suspended matters, and that it rarely exceeds 70 grs. per gallon.

"In seeking to know," says Letheby, "what part of the sewage it is which undergoes decomposition, I have ascertained that it is *not the liquid part* which continues to ferment, but the solid; and this keeps up the putrefactive action for months, evolving large quantities of ammonia, sulphuretted hydrogen, marsh gas, and carbonic acid. It is the sedimentary matter, therefore, which is the chief cause of the offensive effluvium." Again he says, "Wheresover the putrid refuse of a town mixes with a large volume of fresh water, there the process of oxidation is quickly carried out and the offensive matters *are rendered innocuous.* This is effected by the physical power which water possesses of transferring oxygen from the atmosphere to the putrid products; and this power is so great that it will even destroy the soluble organic constituents of ordinary sewage *without farther dilution with water.* I have ascertained, by repeated experiments, that when the clear liquid of common sewage is exposed to the air, it quickly absorbs oxygen and loses its offensive odour. It is the *insoluble organic matter which keeps up the putrefaction* and evolves the noxious gases. This happens because of its being beyond the reach of the salutary influence of atmospheric oxygen. In those sewers, therefore, where the supply of water is large, and the

current is rapid, there is little or no deposit of mud, and the atmosphere *is not particularly offensive.*"

Now, it is exactly this advantageous state of matters that ensures the atmosphere of the Glasgow sewers from becoming "particularly offensive." The city possesses great natural facilities for drainage, and it is certified by the very first engineering authorities, and admitted on all hands, that *the sewers* are *admirably constructed*, and *the runs short and rapid.* The *supply of water is very large*—in an exceptionable degree very large—and the solid matters of sewage have no chance whatever of lodging in the sewers for any considerable time —a few hours is the utmost. On this point I have made several special inquiries of Mr Bateman, and he informs me that "the rate of flow of the sewage within the sewers of Glasgow, and in the intercepting sewers which we have projected, will probably vary, according to quantity and declivity, from two-thirds or three-fourths of a mile to one-half or nearly two miles per hour; and in the syphon pipe across the valley to Pollokshields to two miles per hour and upwards. From thence to the sea I think the speed will vary from one to two miles per hour, according as the quantity of sewage varies in the day. The most distant sewage, therefore, that has to be conveyed *will not be more than seven or eight hours before it is quite out of the city*, nor more than twenty hours in being carried thence to the sea."

Under ordinary circumstances, the fermentative decomposition of solid sewage matter does not begin for three or four days; and as we have in the conditions of the Glasgow sewers powerful retarding influences, it follows that this decomposition is very trifling while the sewage is in the Glasgow sewers.

I shall have another occasion to refer shortly to the sewer gases; but meanwhile I think we may safely assume that any gases that are formed in our Glasgow sewers either remain there, or their escape must be trifling.

I pass now to the consideration of another aspect of the sewage question, to which I am necessarily led by Dr Fergus' argument, and to this I request your special attention. Throughout the whole course of his reasoning he has kept prominently in our view this statement—that a part of the deleterious gases, which he has satisfied himself are evolved from the sewers, make their escape and pass into the atmosphere, and are there unavoidably breathed by us. So far he is correct, and *the question between us is chiefly one of degree.* The danger he wishes us to guard against is a polluted atmosphere. But there is a view of the question that seems to have been entirely overlooked by him. He has restricted his vision exclusively to the gaseous exhalations from the human excreta of the *bowels* and *kidneys*, and has entirely overlooked *the other human excreta* that pollute the atmosphere we breathe.

I fear that he is fascinated by the gaseous *sprite* he has evoked from out the sewers.

> "His charmed eye o'er fifty fair ones roves;
> He *sees* them all, but *looks* at her he loves."

You must bear in mind that the argument *has been worked up by him mainly to a question of polluted*, or, as he phrases it, "contaminated" atmosphere. No question, in my estimation, is more important, for I have never lost the enthusiasm with which I witnessed and assisted in the observations that are recorded in the late Dr D. B. Reid's classical work on Ventilation. And I remember the confirmation my mind received many years back regarding one of these experiments, by the statement of one of our most respected and most eminent teachers of medicine—viz., that in his experience a medical man invariably loses his health when he begins to use a carriage—being destroyed by the contamination of his own breath. This is no small matter, positively or comparatively. Dr Fergus has told you that the annual excreta of the entire

population of Glasgow amounts to 400 millions of lbs. I tell you that it amounts to more than 1000 millions of lbs. I give the amount of millions of lbs. to follow suit, although I fear that the immense mass of figures may have the same bewildering effect as that of the gases of formidable nomenclature. Here is a table of the data, and although different estimates have been made, they all agree closely in the *relative proportions* of the constituents:—

HUMAN EXCRETA IN TWENTY-FOUR HOURS.

	Water.	Solids.		Total.
Bowels, ...	3¾ oz.	1¼ oz.	4½ oz.	5 oz.
Kidneys, ...	45¼ oz.	3¼ oz.		48½ oz.
Lungs, ...	20½ oz.	10¼ oz.	10½ oz.	30¾ oz.
Skin, ...	6½ oz.	¼ oz.		6¾ oz.
Total, ...	76 oz.	15 oz.		91 oz.

You do not require to be told that the matters excreted from the lungs and skin undergo precisely that form of decomposition—*i.e.*, *gaseous*—that Dr Fergus tells us is so dangerous in the case of the other excreta. Now, here is a monster contaminating the atmosphere more terrible still than that of the sewers. Let us try and estimate his vast dimensions. I fear we can form no conception whatever if we handle him so blown up with gas and water. We will, therefore, tap him, and let out the wind and drain away the water, and thus get at the solid substance.

I have made a calculation, from which I find that the total amount by highest estimate of dry solid matter excreted from the bowels and kidneys during an entire year by a population of 500,000 individuals amounts to about 12,500 tons. Of this a large portion is composed of mineral matter, which *does not enter into decomposition of a gaseous nature*, and therefore *does not pass into the atmosphere*. But the same population, during the same period, excretes from the lungs and

skin a quantity of solid matter considerably exceeding 50,000 tons, *all of* which matter is capable of, and *actually does assume, the gaseous form*—is evolved as noxious gases—and passes into and contaminates the atmosphere. Now, I beg of you to note that there is no essential difference, as I have already said, affecting the physiological action, or, for present circumstances, let us call it the sanitary action of the decomposition that takes place in the excreta of the bowels and kidneys, compared with that of the lungs and skin. In the popular and ill-informed mind a distinction may prevail, but none whatever in the educated. We have similar noxious gases, similar sulphuretted hydrogen, similar ammonia, and similar organic vapours. If the subject, therefore, is pursued in the course adopted by Dr Fergus, we must construct tables of "church gases" and "school gases," "barrack-room gases" and "ship cabin gases," and most assuredly "dwelling-house gases."

But I will not drag you over a lengthy reference to the various sides that belong to this many-sided question. If I did, I should have to speak of the excreta of cattle and of horses, which exceeds the amount of human excreta nearly tenfold; I should enlarge upon the facts that, in Glasgow, there is annually manufactured and consumed, so as to contaminate the atmosphere, upwards of 900 millions of cubic feet of carburetted hydrogen, or coal gas—a most noxious gas; that our steam-engines alone, irrespective of our domestic fires, consume upwards of 700,000 tons of coal, all resolved into noxious gases and vapours, each ton of coal representing about 10,000 cubic feet of noxious gases; that upwards of 300,000 oxen, cattle, sheep, and pigs, are slaughtered annually, skinned and disembowelled, contaminating the air with gaseous and animal exhalations, until their remains are finally disposed of; that 13,000 human beings die annually in Glasgow under circumstances of disease which, during their fatal illness, lend additional virulence to the deleterious emanations which

proceed from them during life, and continue to exhale until they are consigned to the grave; and I should not omit to estimate at full value the volatile matters that are the products of the filth of kitchens and washing-houses, stables and cow-houses—of the various liquid and gaseous impurities of trades and manufactures—or of the decay of animal and vegetable food and garbage in markets and storehouses. Dr Fergus tells us that it is the human excreta of the water-closet alone which pollutes the sewers. I wish he could show us in what essential respects all the other matters that do, and necessarily must, enter the sewers differ from human excreta, considered as sewage. Has he really reflected on the nature of these matters, or calculated their amount, when he hazards so bold an assertion? I have ascertained, by careful calculation, that the quantity of solid matter contained in the annual sewage of Glasgow, excluding rain-falls and storms, is about 41,000 tons; while the entire solid matters that have their proper destination in the water-closets are, as I have already shown you, little more than *one-fourth* of that quantity; and yet we are told that water-closets are the *sole* cause of the pollution of the river! I commend all this to your serious consideration.

But, it may be asked, does Dr Adams mean to tell us that the emanations of decaying organic matter are not hurtful? —that the exhalations from sewers are not a source of danger to be guarded against?—that, if the communications between our dwellings and the receptacles into which filth is cast out from our abodes are defective, neglected, or worn out, we are still to remain passive, satisfied, and free from apprehension? I do not mean to tell you so; but I say that the offence and the danger in dealing with this question consist in ignoring the painful experience of the past—in disregarding the utterances of the many eminent sanitary authorities who have conjointly, in special Parliamentary commissions, and separately, by individual warnings, taught us that few sights are so

demoralising and so degrading as the common privies of our lanes and courts and sub-tenements of large towns, and few social institutions that are so likely to lead to a systematic disregard of all the precautions for the preservation of public and of private health; and who assure us that nothing improves the habits so much—nothing civilises a population so much—nothing serves so much to uphold the barriers of at least conventional propriety, that place the sexes in a position of mutual and of self-respect, as improvements in the mode of removing the excreta of the population.

I believe that in the modern water-closet we have an improved social institution based on the truest and best established principles of hygiene, and I am well satisfied that, in comparison, all other systems for removing human excrement from the large towns fall short of these principles.

It is in those places where the modern water-closet system does not exist that we are to look for the presence of those noxious gases of which we have heard so much. It is in those localities that have no sewers that we find disease most active. "It seems really to be the fact," says Dr Aitken, "that the cholera poison (and probably also typhoid fever poison and dysentery), if it can at all be multiplied within the body, almost certainly has its great centres *elsewhere*—namely, in those avoidable foci of corruption where excrement accumulates and decays."

And it is to these "accumulations of excrement" that Dr Fergus invites us to return, although he gilds the pill with deodorants and various little mechanical contrivances, together with hopeful allusions to the manufacture of profitable merchandise. To estimate aright the value of such palliatives, let us glance at the state of things in those places where privies are an institution, and, *par excellence*, let us take Paris, where, like all other institutions, they are under surveillance. There the condition of the privies is regulated by the best provisions that have been approved by councils of health, composed

of the most eminent scientific men, all distinguished by special fitness for the work. Now, I appeal to any one who has been on the Continent, and visited any of these places, to recall his sensations, if possible, and contrast them with those he experiences in a Glasgow water-closet. All kinds of separators for dividing the liquid and solid excrement, and so retarding the fermentative action that is so rapidly engendered in the compost—all kinds of deodorants are and have been in practice, and what is the result?(!) I recollect the first visit to the Continent made by a medical friend in my company—a gentleman connected by early habits with agriculture, and then as strong in his opposition to water-closets as my friend Dr Fergus. In our hotel, one of the very best in Paris, he was so disgusted with the sight of the ramming brush and other little arrangements provided to enable each visitor to be his own sanitary commissioner, that he walked out of the hotel, and, under my guidance, entered a tip-top "*Cabinet d'aisance sans odeur*," situated in the most fashionable boulevard. On rejoining me he did not speak, but walked on, making short convulsive expirations to clear his lungs, while with handkerchief round his fingers he gouged his nostrils. On asking him how he was satisfied, he burst out with an expletive regarding the "stink," which he qualified by a succession of such adjectives as a discreet printer would indicate by ominous dashes, and which had better be imagined than described. He was thoroughly convinced that these things at least were not better managed in France.

If we turn to the countries of the Chinese and Japanese, we find that Dr Fergus' problem has been solved and his counsel the rule of conduct; for there every house diligently treasures up its own putridity and incorporates its own stink. So impressed there is even the humblest domestic circle with the value of Dr Fergus' golden maxim of "the excreta to the soil," that the idlest members are stationed in the highways and by-ways with receptacles

entreating the charitable contributions of benevolent travellers to the family store. But the experience of ages has not led these ingenious people to the discovery of any scheme applicable to the life of European large cities. On this point Professor Blyth, of Cork, the translator of Liebig's latest work, "The Natural Laws of Husbandry"—himself an intelligent advocate for the conservation of human excreta for agricultural purposes—observes, "Chinese rural life, as it is described by travellers, as well as the report of the Japanese system of husbandry given by Dr Maron, would scarcely lead us to wish for the improvement of agriculture upon the plan of these Orientals! The requirements of modern civilisation would not permit the purchase of manuring matter, however valuable, at the cost of all domestic comfort. The sewers must, we fear, still receive what would be offensive to our English senses."

But Dr Fergus hopes, through deodorants and other means, to disguise the filthy matters, and thus to prevent the other senses besides that of smell from being offended. I need scarcely tell you that the chemical appliances that have been recommended for deodorising, disinfecting, and utilising the matters of sewage and of cesspools of large towns are very numerous; and I will not dwell upon the causes that render them *all failures in practice*, so costly and difficult are they in application, and so disappointing in results.* Chemistry has

* All agents hitherto recommended for the deodorisation of sewage, &c., act in one of two modes—they either *check decay* or *destroy offensive properties*. "This they do," says Dr Letheby, "either by fixing the effluvium and forming compounds which are inert, or by breaking up the putrid molecule, and changing its nature, or by expediting the process of decay, and hurrying it on to the last stage of oxidation." The first class are anti-septics or anti-putrescents; the second are deodorisers and disinfectants. The effects of either, as shown in a laboratory experiment, or exhibited in a little bottle at a Society meeting, are frequently very striking. There are, however, many objections to their use. This increases the quantity of solid matter that must be ultimately removed—that cannot be tempered so as to act equally for a given time; another requires costly arrangements for its application, and so on. If used in dwellings, there must, in every case, be provided *stores of the material*, some of which are very bulky; and there must be *some kind of reservoir or*

been unable to solve the problem, although enthusiastic projectors of new and infallible schemes have been furnished with every facility, however costly, and although all desirable time has been freely granted. And engineering science has at length conclusively pronounced that in no way can the filth of large towns be conveyed away with so little trouble or nuisance, or so cheaply, as by water.

Even if deodorisation was successful in practice, and the cost brought within possible bounds—if every house was furnished with its store of deodorants, and every individual was duly instructed, and faithfully performed all the necessary "cabinet" operations, we should still, in a sanitary point of view, be little the gainers; for, with the exception of prepared earth, or, still better, prepared charcoal, deodorants only fix the offensive gases of known composition, removing the offensive smell, but leaving the organic vapours untouched; and it is in these alone, so far as we know, that the property of generating disease exists.* What these organic vapours are has not hitherto been resolved by chemistry, nor has the microscope been more successful. Many of you must be

"*filthy facility*" in which the *conserve* is *retained* until the time when these matters—stored by hand labour or costly mechanical appliances and frequent operations—shall be ultimately removed from the dwelling. Even if practicable in their action, the bare cost, with one exception, of the raw material makes all idea of their use on a large scale quite utopian. I have made, from data furnished by Professor Thos. Anderson, Dr Letheby, and Dr Angus Smith, a rough calculation of the annual cost of such a quantity of six of the best deodorisers as would remove the odour *more or less completely* of the sewage of Glasgow. Here is the result:—Carbolic acid, £2600; quicklime, £30,000; chloride of lime, £47,000; peat charcoal, £192,000; Condy's liquid (*permanganate of potash*), £628,000; Burnett's liquid (*chloride of zinc*), £1,000,000. And this is altogether irrespective of the cost of necessary arrangements for effective application and working expenses.

Of these agents, the best equally for sanitary and for agricultural purposes, and for easy and inexpensive application, viz., carbolic acid, is also the cheapest. It is, however, fortunate for Glasgow that the excellent construction of its sewers, and the abundance of its water supply, render it unnecessary to give serious consideration to any of these appliances.

* See Appendix, Note 5.

acquainted with investigations made by R. D. Thomson, Rainey, and Hassall on the constitution of offensive atmospheres, as elicited under the microscope. I have myself bestowed much labour on this part of the question, but I have learned nothing truly reliable, and I know that nothing truly reliable has been established. Whether, therefore, we speak of a putrid molecule, or of a fermenting atom, we can only refer to a recognised effect. The miasms of pestilential countries—the wards of hospitals—the crowded lairs of the wretchedly poor, have all defied investigation into the secret of their morbific virulence. But two important facts have been ascertained, viz., that, whether in causing sudden death by poisoning, or in generating disease, there do exist atmospheres capable of such, and yet utterly devoid of odour; while many of the most revolting and stinking atmospheres have been proved to be practically harmless. "It is evident," says an able writer on this subject, "that we have still much to learn before we shall fully appreciate the laws of hygiene, and be able to dispel the ignorance which can tolerate so false a faith as that there is no danger from putridity and filth when they are no longer offensive to the sense of smell."

For examples of the deadly effects of mephitic organic vapours, I must ask you to consult French literature, which abounds in references to such instances as being of ordinary occurrence among the workmen employed in clearing out the *fosses d'aisance*, and what may be termed the dry sewers of Paris. In this country they are so rare, that over a period of 60 years there have been but five such accidents in the sewers of London—sewers that exceed 1500 miles in length, while those of Paris are little above 50 miles.*

* In Paris the sewers are for the most part mere drains, communicating with the large sewers which have been constructed to a limited extent in special districts of the city. Essentially, however, the system in Paris is that of the cesspool, or *fosses d'aisance*, fixed or movable, according to the exigencies of the locality. The drains and sewers are chiefly used to carry away the liquid overflow of these cesspools, which are of great size, in many instances 40 feet square and 12 or 16 feet in depth. Those

I will not at this time discuss the defects, whatever those may be, of Messrs Bateman & Bazalgette's plan for the purification of the river, nor the advantages that other schemes are said to possess. I content myself with affirming that the principle on which this scheme is based accords with the best teachings of sanitary science. I have already drawn largely on your time, and I sincerely wish I could have better occupied it. As it is, I feel that I have very inadequately expressed the fulness of my sentiments on this important subject. I regret that I have felt constrained to differ so widely and so totally from my friend Dr Fergus; but I have endeavoured to lay fairly before you some of the reasons which make me decline to follow him as a safe guide. The hearty energy with which he has expressed his conscientious convictions has my unfeigned respect, although tinctured somewhat with a feeling that reminds me of an elderly village matron who, once upon a time, headed a deputation of her strong-minded sisters, when waiting upon a certain reforming sanitary major, whose threatened improvements they looked forward to with much apprehension:—"Na, na, major," she said, "ye may tak' our lives, but ye'll no tak' our middens!"

of the Central Markets (three in number)—where there is "une affluence des visiteurs"—have a conjoint capacity of about 10,000 cubic feet; and those of the Grand Hotel de Louvre (fifteen in number) have a capacity of about 6000 cubic feet. These cesspools are cleared out at stated intervals, varying from several days to several months, and it is in these "filthy facilities" that so many fatal accidents occur. They are constructed under the superintendence of the public authorities, and although professedly water-tight, it is yet well known that this is a fallacy. The gases which are formed blow through the joints; or, under extra pressure, pass through an escape pipe. The liquids, which filter away in spite of precautions, soak into the soil, which thus becomes "excrement sodden." Hence pollution of the wells which furnish drinking water, and hence the diarrhœa that so commonly affects water-drinkers within a few days after a first visit to Paris; and hence, in all probability, the peculiar virulence of cholera when it becomes epidemic in that city.

APPENDIX.

Since reading my communication to the Medico-Chirurgical Society, certain denials, allegations, and misrepresentation of statements have been made, all tending, so far as I am concerned, to obscure the points at issue in the discussion of the sanitary aspect of the sewage question. Some of these are of sufficient importance to merit consideration, and I have dealt with them in the following order:—

I.—The denial of an argument based upon Revelation.
II.—The assertion that I consider the emanations of decomposing animal excreta "harmless"—that is, incapable of injuring health.
III.—The history of a table of chemical analysis, entitled "Products of Sewage Matter."
IV.—The assertion of Dr Fergus, that, in discussing the sanitary aspect of the sewage question—this being the question which interests the general public—he has "followed the leading of the highest sanitary authorities."
V.—Miscellaneous annotations.

I.—The Denial of an Argument based upon Revelation.

Before discussing Dr Fergus' arguments, I endeavoured, in a succinct form, to reproduce them to my hearers; and that I faithfully did so I infer from the fact that my summary was tacitly acquiesced in on the part of Dr Fergus, with one exception, which he made as follows:—In replying, he said (I quote from the Society's reporter), "that, with regard to the argument which he had been alleged to have drawn from Revelation, he begged to state that he had never used the term 'Revelation' at all, but had appealed to the command of Moses, the lawgiver of the Egyptians. Far too much, he thought, had been made of this appeal."

Now, I have it recorded in my notes that Dr Fergus, on two several occasions, advanced the argument referred to, and appealed very emphatically to "Moses" and to "Revelation." I also find that the abstract of his paper, for the accuracy of which the Mail, Herald, and Morning Journal, of October 3d, are responsible, has the following passage:—"*He* (Dr F.) *expressed the opinion that water-closets were contrary*

to Nature and Revelation." It therefore appears that the reporters of the Mail, Herald, and Morning Journal concur with me in asserting that we have it from Dr Fergus' own lips, or (as I wish to speak only for myself) from his own pen, that he did use the words and express the opinion referred to.

However easy on this point, I feel it hard to be told that I made *too much* of the appeal, when I really intended and thought I had made *very little* of it. Indeed, I made as little as courtesy would admit; for I would no more have thought of taking up the time of an intelligent audience in attempting to prove that "Moses" and "Revelation" were not opposed to water-closets, than I would in showing that Moses was *not* the lawgiver of the *Egyptians*, but, on the contrary, that his legislative functions were restricted to the *Jews*. Considering that it was twice used, I thought it only courteous to notice the argument. Dr Fergus seemed to mean to say something on the subject of revelation in its relation to water-closets, and I thought he had said what he meant.

II.—The Assertion that I consider the Emanations of Decomposing Animal Excreta "Harmless"—that is, Incapable of Injuring Health.

I have studiously kept in view the fact that I do not contend that gaseous and vaporous emanations from sewage matter are "perfectly innocuous," "utterly harmless," although the holding of such opinions has, despite my frequent protests, been persistently attributed to me. I have, however, shown that, under ordinary circumstances, they are nowhere present in the relative proportions—quantity and quality—that Dr Fergus has alleged; and that whatever may be their development in London sewers, there is unequivocal evidence to prove that they cannot be produced to the same extent in Glasgow sewers. And it is only because I am so well satisfied that in the modern well-appointed water-closet, with effectively washed and flushed sewers, we are fully protected from even an exceptional hurtful influence that I have undertaken to show that, in the circumstances, present and prospective, of Glasgow, there is nothing whatever to be apprehended from the continuance and the extension of the institution.

That this is the purport of what I said, and what I meant, will not be doubted by any one who reads my argument. Thus it will be noticed that, almost on entering upon the question, I made an emphatic protest against any possible misunderstanding of my sentiments on this point—(see page 6)—and several times afterwards, while striving to prevent the spread of fanciful and exaggerated notions, I showed that I was fully alive to the real danger of such influences. (See pp. 15, 16, 18, &c.) I am therefore somewhat puzzled to account for the persistency with which my protests and clear expressions of opinion have been ignored by Dr Fergus. It may partly be owing to the want of the perceptive power that failed to recognise, even when pointed out, an error in a simple sum of arithmetic—the inability to perceive that 102 is more than 100—that 100 is necessarily the true, or required summation, and that any part of 102 is not a per centage; or it may arise from a

habit of either surrendering or not exercising his own independent judgment when following the leading of high sanitary authority, or it may be the faithless memory which so early denied Moses and Revelation. Whatever the cause may be, the fact indicates a peculiarity of mind.

Those who have honoured me with their attention, have no doubt observed, that while I have carefully recorded my belief that emanations from decomposing human excreta can, and do, under certain circumstances, prove hurtful—not only to the extent of generating disease, but even of causing immediate death—I at the same time have not entered upon any consideration of the *nature* of the injurious influences, their *mode of action*, or *the special diseases* they are capable of causing. On these points I hold matured opinions; but I do not feel that there is any pressure upon me to bring them forward in the present discussion. The question between Dr Fergus and myself is *chiefly one of degree*. I maintain that where there are well-appointed water-closets, soundly constructed sewers, and abundant water supply, the injurious influences referred to cannot exist *to the extent of causing injury to health*, and can only exist in a *minimum degree*. If I am right in this position, it is manifestly altogether unnecessary to follow Dr Fergus into a consideration of the *nature* and *effects* of a cause, when the *cause* itself is *altogether wanting*.

Dr Fergus is either not aware, or he withholds his knowledge, that the products from animal excreta vary according to the conditions to which it is exposed; and, while restricting his search for deodorants and other disguising chemical agencies, he overlooks altogether the admirable virtues of cold water. I cannot, indeed, refrain from expressing my surprise that he, of all men, should not have sympathised with my efforts to show how efficiently the "water cure" acts in the way of removing and destroying filth; and I can almost fancy the genius of Hydropathy hovering over our field of contest, and murmuring in his ear, in reproachful gurgle, "*Et tu Brute!*"

If I am right in my estimate of the virtues of an abundant supply of water as a sanitary agent in the removal and inoffensive decomposition of filth, and if I am right in the statement that the sewers of Glasgow are efficiently constructed, then the only sanitary difficulty remaining is one of petty mechanical detail as to the proper mode of connecting water-closets with the sewers. Any respectable tradesman will tell Dr Fergus that this difficulty has long since been overcome; and if he doubts the tradesman's statement, I must then appeal to the docility with which he "follows the leading of high sanitary authority," and refer him to Dr Parkes' work, where he will find references to arrangements that render the reflux of the dreaded sewer gases "almost impossible."

I have now to notice a statement adopted by Dr Fergus, and declared by him to be "completely established," viz., "That the logical deduction from Dr Adams' argument as to the innocuous nature of the exhalations from our sewers (Glasgow) is, that those from our river are even more harmless."

Keeping in recollection what has been said regarding our sewers at pages 10, 11, 12, &c., where it is evident that a Glasgow sewer is regarded as a smooth lined tube traversed by an ample stream of water, carrying in a few hours away from the city

all sewage matter as fast as it is formed; and, keeping in view what has not been described, but what is notoriously true, that our river is an enormous cesspool that receives the sewage in a condition several stages advanced towards that state when it begins to evolve "sewer gases," and that the inequalities of the sides and depths of this cesspool are loaded with a slimy and sludgy fermenting mass that is only removable in bulk by the never-ceasing operation of dredging, then it is, I think, difficult to imagine sewage matter in circumstances more widely different than when passing through the Glasgow sewers, and afterwards lodging in the river Clyde.

By "a logical deduction," I understand "the inferring of any assertion *from assertions already admitted;*" and, in logic, it is laid down that "when an assertion is proved by the help of others, *there are always at least two assertions necessary* to make the proof or justify the inference." We are all aware of the schoolboy's tricky logic by which he proved that "a horse chestnut is a chestnut horse;" and where truth itself is not the object aimed at, we know how logic can be abused by

> "Making plain things in debate
> Appear confused and intricate."

With these considerations premised, all that has been asserted regarding our sewers and regarding our river is now on record, and I am quite content to leave my readers to draw their own logical deduction.

Leaving this matter of logic to adjust itself, I take the opportunity of stating, shortly, the view in which the present state of our river may be regarded. My only previous reference to the river is made at the opening of my argument, and there I speak of it as a nuisance with which there was an admitted necessity to deal, because it revolted our senses and discredited our civilisation. Efforts, however, are being made to throw back the continued ventilation of the question, and to delay the consideration of proposals for the immediate purification of the river, because an assurance has been given from a good authority that the state of the river has no appreciable effect on the death-rate of the city.

This statement has been eagerly caught up by a community that is fearfully anticipating increased taxation, and it is being echoed wherever interest, ignorance, or indifference can become ruling motives.

In the statement *per se* I quite concur, and I believe it would be extremely difficult, if at all possible, to show conclusively, or in the form of a numerical statement, that fatal illnesses are caused by the exhalations from the river. The expression of the fact is quite fair when used to illustrate the effects that free exposure to the action of air and of a large volume of water has in modifying the injurious influences that otherwise can arise from decaying sewage matter; and I do not understand that the statement was emitted with any other intended application.

This, however, is only one view of the fact; and I think it has been misconceived and put to an unfair use by many who would shrink from an extension of the inference to cases where their own immediate comforts and interests were concerned.

A thing may be a shame and yet not a sin; and one may not be able to prove that the state of the river has an appreciable influence upon the death-rate of the city, and yet be well satisfied that common law, common sense, instinct, and conventional decency are all conjoined in declaring that it is a nuisance, and that it should not be permitted to continue.

The avenue to a gentleman's domain does not lead through his stables, his cow-house, and his ash-pit; and we do not admit our guests by the back court or through our kitchen. The trader who is compelled to make his access to our markets along a highway filled with the flooded filth of our city does not carry away with him impressions that we would willingly have recorded in our history or disseminated among our contemporaries.

We have practically recognised the sanitary advantages of providing public parks, and other open spaces, to be freely used by the masses of our town population, and we know that by so doing we secure for them some of the beneficial influences that in the country nearly double the value of human life. Our parks and open spaces have been well termed the "lungs" of large cities; and, in like metaphor, our rivers may be called the arteries and veins.

Wherever a large stream of water traverses the centre of a town, it carries with it a current of the foul air immediately overhanging, and there follows upon this advancing current a steady rush of pure air which "flushes" the atmosphere of the city. Lateral currents of air converge upon the stream, and the atmosphere within a large area is thus diffused and prevented from stagnating. These movements of the atmosphere are caused by the change in temperature imparted by the water. The water itself, if pure, contributes, partly mechanically, partly chemically, a purifying influence, by absorbing and carrying away with it atmospheric impurities. A river thus becomes a great sanitary agent within a town.

If, however, the water of the stream is impure, it not only fails to remove the impurities of the air, but it contributes much to the contaminations with which the atmosphere is already loaded.

Therefore, in the degree to which a town river is pure or impure, the town itself is benefited or injured, and in a negative manner the death-rate of that town may be affected, although not appreciably.

Then our river is a public highway, and if it traverses a pure atmosphere, how great are the pleasures, and how great are the health-giving influences it can bestow upon the convalescent and the occasionally infirm! Every medical man, who has practised for any length of time in our city, knows the anxiety with which a working-man, stricken with illness, awaits the permission of the doctor to try a day "down the water." The invalid cannot afford, nor safely endure nor enjoy a railway journey, nor be benefited by it. A private or specially-hired conveyance for a day's "outing" is equally beyond his means. He can, however, afford and endure and enjoy "a trip on the river," and would be benefited by it, because the cost is trifling, the mode of transit easy and agreeable, and the senses—in the absence of an impure atmosphere—are stimulated and gratified by the pleasing panorama that

the beautiful scenery of our river unfolds. If his own previous experience, or the doctor's warning, prevents him making trial of the aid that such a sanitary agent as the river in a pure state would prove, or if the impure state of the river counteracts the agency that might so largely contribute to cheer his drooping spirits and restore his health and wasted strength, then, in a negative manner, the death-rate of the city may be affected, although not appreciably.

I am very sensible that, when first emitted, there could be nothing further from the mind of its author than any idea that the expression referred to would be used with the object of retarding the purification of the river; and yet it has been so used, and that very effectively, and it has given rise to much misconception. Thus one gentleman of position, in following up what he supposed to be a legitimate illustration, has publicly declared that he had learned that the ferrymen on the river enjoyed good health. The same fact has been ascertained regarding skinners and glue makers, and other tradesmen who pursue their calling in a polluted atmosphere; and in this communication I have directed special attention to individuals who labour in the atmosphere of sewers. In our own profession we know well what the atmosphere of a dissecting room is, and we know of many other disagreeables that, in the course of our avocations, we must endure because we cannot cure. Would, however, a denizen of our West End Park, who saw a portion of it converted into an enormous dung depot, and its walks traversed with dung carts, be silenced or satisfied, or tolerate the nuisance, because the men who emptied the carts, and laboured among the dung heaps, enjoyed good health, and he was assured that the death-rate of the city was not appreciably affected?

III.—The History of a Table of Chemical Analysis, Entitled "Products of Sewage Matter."

To prevent misconception, or any after "muddling up" of the several points that ought to be kept entirely distinct in connection with the history of a Table of Chemical Analysis, I deem it necessary to give the history in separate sections, viz., (*a*) The Table itself; (*b*) The charges I have preferred against it, and the proofs I have brought forward to establish my charges; (*c*) The use made of the Table by Dr Fergus; (*d*) Circumstances which *followed* the use of the Table, and which *followed* my commentaries upon it.

(*a*) *The Table itself.*

The Table referred to was a large placard, hung up so as to be properly exhibited, and was as follows:—

Products of Sewage Matter—(Letheby.)

Light carburetted hydrogen, ...	73 per cent.
Carbonic acid, ...	16 ,,
Nitrogen, ...	10 ,,
Sulphuretted hydrogen (variable), ...	2 to 3 ,,
Ammonia, and sulphide of ammonium, ...	—
A putrid organic vapour, ...	—

Of course, it could not fail to be understood that these per centages related to the gaseous products only, evolved *in some way or other* from sewage matter. The Table itself gives no details as to any process to which the sewage was subjected.

The essential part of the statements of Dr Fergus, the accuracy of which were questioned by me, is as follows:—"Human excreta *are continually decomposing in the sewers* and giving off gases, some of which, being volatile, the air passes up into our houses, poisoning the air we breathe. . . . . We are *breathing continually;* and fancy having the air we breathe contaminated with sewer gases! These are sulphuretted hydrogen, sulphide of ammonium, carbonic acid, and, occasionally, phosphoretted hydrogen and free ammonia, which render sewer gas alkaline, and a putrid organic vapour, which is also ammoniacal. Dr Letheby tells us that ordinary London sewage gives out 1 to 1½ cubic inches of gas per gallon per hour, *the composition of which is stated* in the table."

(*b*) *The charges I have preferred against the Table, and the proofs I have brought forward to establish my charges.*

Among other objections to this Table, I urged (1) that it was inaccurate as a Table, *apart from all authorship;* and (2) that *it did not truly represent the results of Dr Letheby's experimental investigations*, for which it was professedly brought forward.

I refer to p. 9 *et seq.* for the details of the manner in which I proved that my objections were valid; and considering the time, place, and circumstances, it is difficult to conceive how more could have been done to show that the data offered by the Table *could not by any possibility* be correct, but were necessarily erroneous, delusive, and unsubstantial. I am well informed that, unless in the case of Dr Fergus himself, who would admit no error, there was no doubt left in the minds of my hearers.

But Dr Fergus not only refused to admit that there was error, but he has since stated in the public prints that my "own assertion" was the "only proof" I brought before the Society, and that he still waits, and requests others to wait, for actual proof.

Under these circumstances, it was only left for me to apply directly to Dr Letheby himself, and I am happy to have the opportunity of submitting to my readers a complete and decisive corroboration of all that I have advanced regarding the Table.

In my main argument I have given at length my interpretation of the Table; and the reader is requested to keep my comments in view while he reads Dr Letheby's explanation of his own views and investigations. I forwarded to him a copy of the Table, and asked if he accepted it as one issued by himself, and if it truly represented or gave an intelligible or correct exposition of his investigations. He very kindly and promptly favoured me with the following reply, which, besides its conclusive fiat upon the point at issue, furnishes additional matter of extreme interest and high value in relation to other points:—

"*Nov.* 5, 1868.

"DEAR SIR,—There is a mistake in the figures, which you say were given in the Table of "*Products of Sewage Matter*," and chiefly in the proportion of sulphuretted hydrogen in the gaseous products; for the largest amount of this gas in the naturally evolved gases is but 0.2 per cent. of the entire gas.

"My Table (No. X.) shows three sets of facts:—

"1st. The quantity of gas evolved from sewers during the entire time of decomposition (air being excluded), and the composition of the gas; and, for obvious reasons, a very bad sewage, containing as much as 128·8 grains of organic matter [and 149·7 grs. of mineral matter.—J. A.] per gallon was used. This sewage (with atmospheric air excluded) went on decomposing and evolving gas for nine weeks, and the average amount of gas evolved per hour for the whole time was 1·2 cubic inches per gallon of sewage. This gas had an average composition by volume of

Marsh gas, ...	73·833
Carbonic acid, ...	15·899
Nitrogen, ...	10·187
Sulphuretted hydrogen, ...	0·081
	100·000

"2nd. The quantity of gas dissolved in sewage, when in a state of active fermentation, and the composition of the gas. Here, for the sake of comparison, I examined *very bad* sewage (averaging 101.8 grains of *organic* matter per gallon), and *ordinary* sewage (averaging 27 grains of organic matter per gallon). These contained and evolved the following proportions of gas when boiled for some time:—

Bad sewage, ...	76·5	cubic inches per gal.
Ordinary do., ...	33·1	" "

And the composition of the gas was

	Bad Sewage.	Ord. Sewage.
Marsh gas, ...	20·352	13·352
Carbonic acid, ...	72·245	35·962
Nitrogen, ...	4·320	49·725
Sulphuretted hydrogen, ...	3·083	0·961
	100·000	100·000

"3rd. The quantity of gas contained in diluted sewage, as the marginal water of the Thames at Blackfriars and London Bridge at high and low tide.

"This evolved an average amount of 10·3 cubic inches of gas per gallon when it was boiled for some time, and the gas consisted of

Marsh gas, ...	trace.
Carbonic acid, ...	59·613
Nitrogen, ...	40·387
Sulphuretted hydrogen, ...	traces.
	100·000

"It may be said, therefore, that the gases evolved from ordinary sewage, *in the presence of atmospheric air, are chiefly carbonic acid and nitrogen*, with but mere traces of sulphuretted hydrogen.

"I find, however, from an extensive series of experiments, made in 1866, with carbolic acid *in the sewers of the city*, that the gases evolved from the sewage were chiefly marsh gas, thus:—

Marsh gas, ...	88·45
Carbonic acid, ...	5·48
Nitrogen, ...	6·07
Sulphuretted hydrogen, ...	none.

"My attention was directed to this in consequence of the frequent firing of the sewer gases by the candles of the sewer men, and I had the gas collected from the sewage in the sewers. The carbolic acid had evidently checked oxidation and promoted the marsh gas decomposition.—Truly yours,

(Signed) "H. LETHEBY."

I suppose there will now be no difficulty in admitting that my reference to Dr Letheby's official Report, and my interpretation of his investigations as contained in my main argument, proved then and there that the data exhibited by Dr F. was "erroneous, delusive, and unsubstantial," and that my "own assertion" was not "the only proof" brought before the Society.

(c) *The use made of the Table by Dr Fergus.*

Dr Fergus used the Table entitled "Products of Sewage Matter," together with the words I have appended to it, as a definite and authoritative statement of the *Quantity*, *Quality*, and relative *Proportions* of the noxious gases that are given off in *all sewers*, by *ordinary sewage*, *under the ordinary circumstances* in which sewage is found in sewers.

Beyond this his argument consisted mainly of narratives of special cases of diseases, which he stated were illustrations of the hurtful effects of the gases referred to, and of assertions that no contrivances could exclude those gases from a dwelling that is provided with a water-closet.

He thus made the Table the *premise* or *major proposition* of his argument.

I, however, challenged the soundness of his *premise*, and showed that sewage, *under ordinary circumstances*, never furnished the noxious emanations referred to, either in the quantity, quality, or relative proportions stated by Dr Fergus; and I maintained that Dr Fergus, by the use of this Table, and by the manner in which he made it bear upon and illustrate his arguments, conveyed, or attempted to convey, an exaggerated notion of the evils which can arise from sewage *as it is found in Glasgow sewers*.

He has done this by citing the products resulting from sewage subjected to *laboratory* experiments, whereby there is obtained the greatest quantity of noxious

gases that sewage can possibly furnish under any circumstances, but which is never furnished by sewage under ordinary circumstances, as it is found in sewers, and from sewage that was *exceptionally impure*, and which therefore furnished an exceptionally large quantity of noxious products, after being placed in exceptional conditions.

Owing to the same error of using the results of laboratory experiments, he has conveyed an exaggerated notion of the *quality* of the gases that are produced by sewage under ordinary circumstances. Thus, the most deadly of these products is sulphuretted hydrogen, and it is stated to be present in a proportion of from 2 to 3 per cent., whereas it is never evolved, under ordinary circumstances, in a proportion exceeding 0·2, or about the fifteenth part of the amount stated by Dr Fergus.

In like manner, a totally unreliable notion is conveyed of the *relative proportions* in which the several gaseous products are evolved from sewage placed in ordinary conditions.

A friend of acute, critical mind, whose opinion I obtained on this point, says that Dr Fergus "is open to the charge of having failed to explain *the true bearing* of the per centages in the Table *upon the question at issue—e.g.*, a tumbler of Harrowgate water would probably yield, by boiling, a much larger per centage of sulphuretted hydrogen than the most highly charged sewer water in London; yet Dr Fergus would not argue that the *spontaneous* exhalations of Harrowgate water could, under any circumstances, become so dangerous as the composition of the gases of its ebullition would suggest." To this extent the gentleman thinks Dr Fergus is fairly open to criticism, and he suggests that Dr Fergus ought "to remove carefully from his paper all inaccurately worded statistics and all expressions which might tend to suggest an erroneous application of the per centage of gases extracted from sewer water."

The points to which my criticisms were directed are here brought clearly forth, viz., his "having failed to explain the true bearing" of the Table, and "the use of *inaccurately worded statistics* and *expressions which might tend to suggest an erroneous application.*"

Dr Fergus could not, however, explain, for the simple reason that he did not himself understand them. He had, as I have previously stated, altogether misapprehended the data he was using.

(*d*) *Circumstances which* followed *the use of the Table, and* followed *my commentaries upon the Table.*

Dr Fergus, when replying to my argument, introduced, for the first time, the name of Dr Parkes, from whose work on Hygiene, and not from Dr Letheby's writings, he stated that the Table was taken *verbatim.*

I thereupon exonerated Dr Fergus from the errors in the compilation of the Table, but kept in view that this did not in any degree alter the fact that the errors still existed.

Shortly afterwards, Dr Fergus published a letter, in which this kindly intended

acknowledgment, confirmed by private letter, was travestied, and I was placed in the position of having withdrawn from my ground. (See Letter in last Note of Appendix.)

I had not previously concerned myself in following up the reference to Dr Parkes, as the mere authorship of the erroneous Table had no influence either upon Dr Fergus' argument or mine. Still I suspected that, as neither Dr Letheby nor myself had been fairly represented, there might be a similar failure in connection with Dr Parkes. I accordingly turned to Dr Parkes' work on "Practical Hygiene," and found my suspicions verified.

I may here observe that Dr Parkes' work is the only one in which I have found, in a condensed form, so well digested a mass of valuable matter—almost invariably accurate and reliable. All parts of this work are so kept *en rapport*, by references and correlative facts, that any professional man resorting to it, and applying a moderate share of attention to the subject on which he wishes information, can scarcely imbibe an erroneous view, although, in some matter of detail, he might stumble upon an error.

In Dr Parkes' work there is a chapter headed "Products of Sewage Matter," embracing several sets of facts, all evidently requiring to be examined under the guidance of the principle on which the book itself is constructed. This chapter contains the Table, *but with no title*, and in reference to it Dr Parkes says, "Ordinary London sewage disengages from 1 to 1½ cubic inches of gas per hour per gallon (Letheby), consisting of"— (Here follows the Table.) No explanation is given of the *manner* in which the gas is *disengaged*. The chapter then refers very shortly to "the liquid which collects on the walls of sewers," to "the organic vapours," to what "is found in sewer water," to "the air in sewers," and to "the asphyxiating gases" of sewers.

From this chapter Dr Fergus has extracted the Table, which is evidently intended to represent one set of facts, and has given to it the title which rightly designates the entire chapter. How far he is justified in so doing it does not, in the present discussion, concern me to inquire; but some light might be thrown on such an inquiry by a reference to the immediately preceding chapter of Dr Parkes' work, headed "Products of Combustion." In this chapter there is shown the very noxious "products" which "pass into the atmosphere at large" from *coal*, such as carbonic acid, sulphide of ammonium, sulphide of carbon, sulphuric acid, &c. There is also shown the "products" of *wood*, such as carbonic acids, and oxides, &c.—that is, when the wood is "decomposing" by exposure to heat and atmospheric air, for, if *decomposed* by heat, with air excluded, we would, no doubt, be told that pyroligneous acid and tar would be the products given off. Then we are told of the "product" *coal gas*, to which I request Dr Fergus' attention, because it is really of very deleterious composition, and consists in large proportion of light carburetted hydrogen, carbonic acid, sulphuretted hydrogen, and sulphide of ammonium—very similar, indeed, in many respects to the composition in Dr Fergus' Table of the "Products of Sewage Matter." Dr Parkes' work treats of other "products" all passing into

the atmosphere, and "contaminating the air" which "we are continually breathing." The student is, however, reminded, at the beginning of the section, which embraces "products" of combustion and of sewage matter, that to compensate for these contaminations "a wonderful series of processes goes on in the atmosphere as on the earth, which keeps the air in a state of purity." In a pithy and admirably clear summary, the learner is reminded that "gases diffuse" and "become so diluted as to be innocuous," and that "diffusion, dilution by winds, oxidation, and the fall of rain, are the great purifiers," and that by these "counterbalancing agencies it is wonderful how the immense impurity which daily passes into the air is soon removed, except when the perverse ingenuity of man opposes some obstacle, or makes too great a demand even upon the purifying power of nature."

After a careful examination of all that relates to the "Products of Sewage Matter," *and to the separate section on sewerage* in Dr Parkes' work, I found that the soundest and most judicious *conclusions* were carefully inculcated. I therefore wrote to Dr Parkes directing his attention to the chapter, or section, headed Products of Sewage, and I now append his reply, premising, that whatever ambiguity may exist in the *popular* treatise referred to, there is none whatever in Dr Letheby's *official* Report, or in his letter at page 34 :—

8th November, 1868.

"My dear Sir,—I conceive the *section* at page 79 of my Manual of Hygiene, headed 'Products of Sewage Matter,' is quite correct. There are two points noted —1*st*, The nature of the substances disengaged from decomposing sewage; and 2*dly*, The composition of the air in the sewers into which these products are disengaged.

"I gave a Table, taken chiefly from Letheby's own account in the *Encyclopædia Britannica* (article Sanitary Science) of his experiments. The only addition I made to this Table was an item of sulphuretted hydrogen, which was quite necessary to prevent subsequent statements from being inconsistent.

"Then the second point—*the composition of the air in sewers*—is given in the last two paragraphs of the section.

"Now, here I thought, and do still think, that a Table of the average composition of sewer air is of little use; still more useless is a Table of the composition of a well-ventilated sewer. What is wanted is to know the limits of impurity. You will see, therefore, I stated the case in this way: I gave the lowest amount of oxygen recorded in sewer air, and said the amount might vary from this to the normal amount. I then gave the extremes of sulphuretted hydrogen and of carbonic acid, &c., which might occur; and of course it is implied that the amount of these substances might be from the stated extreme quantity to *almost complete absence* in the air of perfectly ventilated sewers.

"I still think this plan of statement safer, as indicating the *possible impurities* and consequent danger.

"Believe me, very sincerely, yours,

(Signed) "E. A. PARKES."

Before leaving this "unlucky Table of sewer gases," I may state that under ordinary circumstances I would not have thought it necessary to have criticised it so closely as I did at the Society meeting; but, *ex pede Herculem.* That Table was but a small matter considered *per se.* When, however, a professional man comes forward, stating that his object is to change the habits of a people—when he denounces an institution, the sanitary advantages of which we have been taught to believe in as accepted facts—when he urges us at enormous cost to alter the constructive economy of our dwellings—and when he states that in all this he feels the responsibility of dealing with what he considers to be "the most important sanitary question of the day"—then it is surely right that, if he can base nothing on original research, he should at least exercise the most critical vigilance when he employs the researches, or makes any use whatever of the statements of others. The data, or alleged facts, given in that Table was not matter of *mere testimony, which could be verified in no way except by appeal to Dr Parkes' credibility or well known accuracy*, but matter of experiment and of fact, which, in the circumstances Dr Fergus had no right to assume as accurate *without some measure of personal verification*, since he made the data in that Table the main basis of his argument. In such a case he was more responsible for the data than Dr Parkes himself, who, in a large work, might unwittingly allow an inaccuracy of the kind described in the Table to escape him, but who would instantly have detected the errors if he had designed, like Dr Fergus, to make the data there given the foundation of a special argument and the main point of proof. The Table is made use of by Dr Parkes in no such special way, but it was so made use of by Dr Fergus, to reach conclusions which are wholly at variance with the views given in Dr Parkes' work —a fact which makes the act of so using the Table all the more reprehensible.

If I had been commenting on that Table as I find it placed in Dr Parkes' work, I would have pointed out the discrepancy in the summation, the difference in the per centage of sulphuretted hydrogen from that given by Dr Letheby, and the absence of explanation as to the manner in which the gases were disengaged from the sewage; and these I would have said were points to be amended in future editions. In the case before us, however, the Table was made to form the fabric and colouring of the flag that was being flaunted in the eyes of the public to goad it into panic, and hence the necessity of acting energetically, and, in reference to it, of dropping the honied mouthings of debate that might have been appropriate in discussing the merits of an embrocation, or the composition of a poultice.

IV.—The Assertion of Dr Fergus, that, in Discussing the Sanitary Aspect of the Sewage Question—this being the Question which interests the General Public—he has "followed the Leading of the Highest Sanitary Authorities."

The battle that Dr Fergus has attempted to revive was decided many years ago, and the details are familiar to all who have lived in the atmosphere of medical

circles. Previous to 1840, there prevailed the system of cess-pools, pots, or reservoirs, outside each house or group of houses, and the sewers merely received the partial escape or overflow of liquid impurity, while the liquid which did not overflow soaked away into the sub-soil. Closely following the labours of Parliamentary Commissions into the state of the Public Health, the use of water-closets became more general, confined at first to the houses of the wealthy, but gradually and steadily becoming common among other classes as their sanitary advantages and the evils of the old system became better known. Their extended use met at first with much opposition, owing to ignorance of facts and the existence of interested motives; to the dislike, for instance, which owners of house property had to any interference with the existing arrangements of that property as to changes that involved expense; to the dislike of the inhabitants of towns to a new imposition of rates; and to many other causes which are known to retard the progress of improvements of which the utility and desirableness are otherwise not called in question. Ultimately, however, the issue of the struggle may be said to be gazetted in the following words taken from the preliminary Report of a Parliamentary Commission on the Sewage of Towns, 1858:—

"It is undoubtedly in a growing acquaintance with the laws of health, which we have derived, during the present century, from the devoted labours of eminent men, *principally of the medical profession*, that we must seek for the origin of those extensive changes which have brought us to the present condition with regard to town sewage.

"These labours have led to certain practical conclusions, which we may sum up very shortly in the shape of two or three axioms:—That the offensive effluvia given off by animal and vegetable substances in a state of decay are highly prejudicial to health and productive of diseases of the worst forms; that decaying human excrements, solid and liquid, are among the most injurious of such substances; that the retention in cesspools of such decaying matter beneath and around the dwellings of crowded populations is a serious nuisance, and that for the rapid and regular removal of such substances immediately after their formation, and before they can become a source of offence and disease, the only practicable means is an abundant employment of water—that is to say, the adoption of some form of water-closet."

Serious evils were, however, soon observed to follow upon the extended use of water-closets. Hitherto, the sewers had been employed exclusively for carrying away the surface waters of the towns. When, however, the practice was introduced of flushing house drains into the sewers, then the night soil began to find its way into the rivers. The rivers were becoming fouled to an extent that interfered with the convenience and comfort of the people and endangered public health. The sewers being of limited capacity, and not originally constructed for the offices they were now being made to serve, proved inadequate. Moreover, the flow of water in the sewers was scanty and irregular—they got choked up—noxious exhalations

accumulated and regurgitated into the house drains—the drains were unprovided with other traps than mere gratings, for there had been no previous necessity for other contrivances. Hence arose many instances of discomfort and injury to health. At the same time, it became more and more widely known that the same facts which established the sanitary advantages of water-closets showed that, wherever water supplies for drinking purposes were obtained from wells, there was frequent danger of infected matters being conveyed into the wells from the drainage of cess-pools, dung-heaps, and dry privies, &c. Medical men now began to send forth warning cries, each as his peculiar opportunities inclined him to take up special interests. Some eminent men, as Dr Acland, urged the attention of the Legislature to the necessity of guarding rivers, the basins of rivers, and entire watersheds from pollution. Other earnest investigators, as Drs Snow and Murchison, drew the attention of their medical brethren to the injurious influence upon health of imperfect drainage and sewage, and of insufficient or of imperfect water supply. Through such exertions, and by the agency of such labourers, medical men of mature years, and more lately medical students, the local authorities of towns, and the better educated of the general public, are gradually becoming enlightened on the subject of sewage; and from time to time, as the movement in favour of sanitary progress reaches a locality, there generally commences an agitation such as now exists in Glasgow. This agitation invariably assumes the same form, viz., an endeavour, on the part of the community, to conform to the requirements of advancing civilisation by the improvement of social habits, but always, if possible, with the proviso of some immediate or ultimate assurance against increase of local tax burdens.

Hence the origin of special Parliamentary Commissions, and of experiments on a large scale for the deodorisation and utilisation of sewage matter, the result of which has ripened to a degree that the question is regarded as solved by all earnest inquirers. That question, viz., the disposal of town sewage, it is not my present intention or object to discuss. I have neither time nor inclination for the task; and I merely allude to it *en passant*, feeling perfectly assured that the same spirit and intelligence that secured for the city of Glasgow a pure water supply that is pre-eminent among cities, that secured it against as stubborn a battle of predictions that experience has falsified, and of interests that are now thoroughly reconciled, and in the results fully compensated, will likewise secure the efficient disposal of the sewage to a locality where it can be dealt with safely as regards the public health, and with economic advantages as regards the public purse.

In the reports of Parliamentary Commissions, in special reports to the Board of Health, and to the Privy Council, and in separate writings of many distinguished medical men, there is contained a great mass of evidence, showing, both in an isolated and in a collective form, the facts which illustrate the conclusions to which I have adverted in the preceding short and rapid sketch.

Familiar as these writings are to the majority of well-informed medical men—as familiar as "the Shorter Catechism with proofs" is to intending church probationers—the present discussion has afforded a convincing and surprising illustration that they

may be misunderstood. I can only account for this occurrence by supposing a pre-occupied state of mind. Don Quixote, when he went forth on his mission of reforming abuses, attacked decent going windmills as destroying giants, and invested his frowsy Dulcinea with all the attributes that chivalric courtesy can assign. And, in like manner, Dr Fergus, in his onslaught upon the water-closets, is evidently stimulated by a passion for an "idol of the mind"—than which there is no greater obstacle to the entrance of true light. The mind so pre-occupied affords a marked illustration of two very different conditions of sense—the difference that exists between *seeing* and *perceiving*. Thus an individual fails to perceive the spectacles on his nose, and another in a search for a familiar face may retire from a crowd and retain no lasting impression of the thousands of indifferent and unregarded faces that met his vision.

Indeed it is a most significant fact, but one that is to me not at all surprising, that, although brought under the notice of the Medico-Chirurgical Society *at three consecutive meetings*, there was not one medical man who had a word to say in support of Dr Fergus' peculiar views. There was, by the way, an exception, for one gentleman contributed a support that consisted mainly in the reading of an early opinion (since recanted) from an old report of Dr Anderson and Mr Bateman, and which opinion was adverse to the water-closet system. This exceptional support may therefore be recorded at its full value. Another significant fact may also be recorded. When Dr Fergus first read his communication, with its voluminous "extracts from high sanitary authorities," he was heard respectfully and with interest, although it was plainly seen to what use he intended to put them; and at the second meeting he was heard with patience, in the expectation that something better than "extracts" would be forthcoming. But when at the third meeting there was nothing adduced but "additional extracts," it was not surprising that he obtained a reluctant hearing from a wearied auditory, or that he was so entreated to "make it short." If he had not been, to use the words of his own appeal, "almost a stranger in the Society," he would have known that, while he was reading "another" and "another extract," with all the zeal of an enthusiast inculcating truths to a knowledge of which he was himself newly awakened, he was only "cramming the ears" of his hearers "against the stomachs of their sense," and that to them the *rechauffé* of details was only inflicting the repetition of a well conned lesson. He would have known that he was addressing men to whom fever and its exciting causes was no new subject—men who had associated with cotemporaries whose names are classic in medical literature, and who had many times, within the Society walls, heard these cotemporaries expound all that science and experience records on the subject of fever as a question of public health.

The manner in which these "extracts" were made to do service was, however, a novelty to the medical mind, and at first came with all the exciting feelings of a surprise. But it was a mere startle, and no hearer was moved from the path in which his experience and convictions had previously inclined him to travel.

Every medical man who heard these "extracts," recognised immediately that they were the old familiar warnings against drinking "sewage dissolved in water"—against "living on excrement-sodden earth"—against permitting "filthy facilities to exist for the fouling of earth, and air, and water"—against disposing of sewage "in such a way" that sewer gases "confined in the pipes," and "having no other exit," are forced into our houses—against permitting the existence of "cesspools" where, "during times of drought," foul gases may be engendered, but from the effects of which gases we may be delivered promptly and easily, as in the latest "extract" published by Dr Fergus, where "the fever subsided as soon as openings were made into the sewers from certain houses where it had before maintained itself for months."

Something of that blindness which is caused by excess of light must exist in the case of an individual who can study the writings of the highest sanitary authorities and fail to perceive the clear expression of the opinions to which they give utterance in reference to the sewage question. Even a casual perusal, conjoined with a habit of "skipping," will scarce save the reader from falling plump upon some of the numerous passages by means of which these authorities iterate their opinions. The sensational "extracts" quoted by Dr Fergus are merely the illustrations they advance to show the soundness of their views, and the necessity that exists for adopting their conclusions. The authorities are numerous, and if the space I have assigned myself should limit my comments to those who have been selected and brought forward by Dr Fergus himself, I shall nevertheless be well content. They are among the very first, and no better names can well be adduced than those of Mr Simon, and Drs Murchison, Parkes, and Acland.

How shall we know the views of these gentlemen? Not by the extracts to which I have so often referred, for these, as I have stated, are applied to uses which their authors never intended. But no possible mistake can arise if their opinions are quoted in their own words, and this I shall now do.

Commencing with Mr Simon, medical officer to the Privy Council, author of reports to the Board of Health, &c., and oftentimes a member sitting on Parliamentary Commissions specially appointed to make inquiry on questions affecting the public health, his opinions have been frequently expressed, and probably nowhere better than in the quotation from a Parliamentary report, at page 40, to which his name will be found appended.* That is one expression of his opinion. Here is another, where, in the course of animadverting upon a faulty district, he says—"The solid fœcal matter of the inhabitants is still retained amidst their dwellings, *instead of being discharged into their sewers.* The mass of the people are denied the *comfort and advantage of water-closets*, and, *in spite of all medical evidence* of the perniciousness of the cesspool and middenstead system, it seems probable these will be maintained in this district longer than in any other; for even in these towns in which a complete system of sewers has been laid down, the noxious middenstead, pent up in confined yards and courts, remains as a rule. If one of the two evils were unavoid-

* Parliamentary Report on Best Mode of Distributing Sewage of Towns. August, 1861.

able, it would be better that the rivers should be polluted than that the atmosphere in which we live should be subject to constant deterioration."

The next authority, Dr Murchison, is nowhere explicit on the subject of water-closets—that is, he has not, so far as I am aware, been called upon, like Mr Simon or Dr Parkes, specially to treat the question; and he can only, therefore, be held responsible for such inferences as can be derived from his very important observations on the spontaneous generation of typhoid, or, as it is frequently called, gastric fever. He has endeavoured to explain how *pythogenic*, another name for enteric or gastric fever, is endemic, or circumscribed in many localities, and the evidence he adduces (p. 438 *et seq.* of his book on fevers) to show that it can arise from the emanations of decomposing fæcal matter is very striking. He tells us of many instances of illness arising from the clearing out of *a choked up drain;* from living in a room *over a stable and cesspool* which had become *choked up*, and from which issued smells so offensive that the horses had sometimes to be removed; from the open course of a stream that had been conveying sewage, but which stream had *dried up* during extremely hot weather; from a *stagnant pool* which was *the receptacle of dead animals and of all the sewage of the district;* from the main sewers being all *closed up* and *obstructed with accumulated filth* proceeding from the privies and farm yard; from *a foul and neglected sewer* in which fæcal matter had been *accumulating for years without any exit;* from exposure to the fetid emanations liberated during *the opening and emptying of cesspools*, the cleansing of *old drains* and open ditches, and to the foul gases which were found in the houses *when any obstruction took place* in the narrow drain pipes; from *an accumulation of upwards of ten feet of soil that had been going on for years*, &c., &c. He says that "in most of the instances where enteric fever had been traced to *bad drainage*, the noxious gases have escaped into the interior of the houses. Hence, a privy outside a house is much less dangerous than *a badly appointed water-closet* within." He "readily admits that we cannot succeed in tracing every case of enteric fever to organic impurities;" but during the last four years he "has met with few examples of enteric fever, which, on investigation, he could not trace to *defective drainage.*"

Among those labourers, therefore, who have done good service in showing the evils which arise from permitting filthy facilities to exist for polluting earth, and air, and water, Dr Murchison deserves honourable mention.

I shall now adduce Dr Parkes, of whom Dr Fergus says—"Every medical man knows the high standing of Dr Parkes, and that in the English language we have no better authority on hygiene than his work." I gladly seize the opportunity of showing that there are some points on which Dr Fergus and myself are agreed, by subscribing cordially to the foregoing statement, and I will only add that Dr Parkes' opinions have the force of *injunctions*, owing to the official and authoritative position he holds in relation of the Army Medical Department. His views are, therefore, given under the weight of responsibility.

Under that chapter of his work in which Dr Parkes treats of sewage, he says:—"The question of the proper mode of disposal of sewage has been somewhat per-

plexed by not keeping apart two separate considerations. *The object of the physician is to remove as rapidly as possible all excreta from dwellings*, so that the air shall not be made impure. The agriculturist wishes to obtain from the sewage its fertilising powers. It is not easy to satisfy both parties; but it will probably be conceded that *safety is the first thing to be sought*, and that profit must come afterwards.

"There are only two modes of removing sewage from dwellings. It must be washed away by water, or it must be carried or carted away to such a distance as to be innocuous, or partly washed away and partly carried by hand. It must not be about houses, or be buried in pits, which is only one degree better—if, indeed, it is better.

"If the supply of water be sufficient, and if sewers are efficient, *this is by far the readiest and most inexpensive way* of disposing of the excretions. The sewage matter *is at once diluted with water, and washed away* to a distance. On the other hand, *if sewers are badly made*, and *if the amount of water be insufficient*, they are worse than useless, as they have the appearance of efficiency without the reality."

Dr Parkes then refers to the matters that require attention "in order that sewers may be efficient," such as construction, water supply, ventilation, not opening into basement of houses, as no *traps* will prevent the gases from rising into the warmer atmosphere of a dwelling-house, &c. Regarding water supply, he says:—"It has already been stated in the chapter on Water that, to keep sewage clear, the amount of water, in addition to rainfall, must be 25 gallons per head daily."

He proceeds to say that: "*In case there is any suspicion of diseases connected with sewage*, the examination should be conducted in the order of the previous paragraphs, viz., the kind of sewage; their fall; the velocity of the current in them, and the amount of their discharge, actual (if it can be ascertained) and calculated; their condition as to construction; ending and trapping; ventilation and amount of water. The facts just given will serve as a guide to show if *any defect exists* in any of these points."

Regarding the *form* of water-closets, he thinks "little need be said. A simple syphon, with a good flow of water (10 gallons), *is as good as anything*, and it is easily cleaned if it gets out of order. Mr Jennings has patented a syphon with a plug, *which would seem to render reflux of gas almost impossible*."

Under the heading of "General Conclusions," he says:—"Bearing in mind that the problem with which we deal is *the immediate and complete removal of excreta from our dwellings*, the following conclusions seem justified:—If our opinion is asked regarding *the best method* to be adopted in a temperate climate, *we should advise removal by water*, provided there is water enough, good fall, and proper means of disposal of the sewage, and, of course, available materials for properly constructing the sewers. All these points should be carefully considered. It must be understood, however, that this plan renders the sewage *comparatively* valueless.

"If the plan by water *cannot* be adopted, one of the dry methods must be used, and of these the mixing with dried earth is the cheapest, and probably the best. *This requires, however, much greater labour and superintendence;* but if the soil is saleable, it may repay this. Even if not saleable, it may be considered to fairly repay

its cost, in the case of barracks, if it is applied to soldiers' gardens. In many stations, *where water is scarce,* this plan must be adopted. Only *until there is greater evidence* about the complete deodorisation *and innocuousness* of the mixed soil and earth, when retained in houses (especially in the tropics), *it would be desirable to have the earth-closets always external to the houses,* and, *if possible, the soil should be removed daily.*"

The value of the foregoing expression of Dr Parkes' carefully matured conclusions will justify the length of my quotations, and they are, I think, as explicit as language can make them.

The next of the sanitary authorities, whose leading Dr Fergus says he is following, is Dr Acland, Regius Professor of Medicine at Oxford. This gentleman has given a great deal of attention to the subject of the pollution of streams, and his inquiries have been pursued in a systematic and extensive manner. I was greatly puzzled on what grounds he had been cited and his name used to give support to Dr Fergus' conclusions, because it was evident to me that, in his published writings, he had proved the possession of an extensive practical knowledge of questions affecting the public health. The same evidence assured me that his opinions, if anywhere expressed, would be given in carefully accurate language, and would almost certainly be derived from personal investigation. He had, I knew, stated emphatically his views regarding the allowing of animal excreta to remain "within the precincts of the house," and had said that the evils of such "could not be exaggerated;" in fact, he thought "they could not be expressed sufficiently strong." He had also said—and I mention this *en passant*, because the fact is connected with his special line of investigation—"As to the general fact that the neighbourhood of polluted streams is a cause of death, I have not the slightest doubt." With regard, however, to his views on land carriage of sewage, and the comparative merits of water-closets and earth-closets, I could find no special expression. I therefore addressed to him some explicit inquiries, to which he most kindly and promptly furnished the following reply:—

"*November* 12, 1868.

"My dear Sir,—No one has any ground for claiming me as an advocate for cesspools, earth-closets, or any substitute whatsoever for entire removal of sewage by water from large towns.

"I have never written or spoken a word in public or private in a contrary sense.

"I have, on various occasions, public and private, calmly discussed the several methods, and I have insisted mainly on one principle, viz., that every great town has to be considered *in its own circumstances* by a skilled and honest engineer.

"I feel this so strongly, that I have always refused to say how, *in the abstract*, a town should be sewered.

"One place has good water supply, and sufficient fall, and land below the town fit for receiving sewage by gravitation for irrigation purposes. There the problem is so simple as to have only one complication—the disposal of surface rain-water.

"Another town is quite flat, has bad water supply, and no fall near, and has the

houses wide apart, and is poor. There I can quite imagine that a regulated system of closets or tanks may be successful for health and economical. But this is a rare case, and wholly inapplicable to large towns.

"To them I believe there is no sound method yet known, but taking the sewage by water to the land.

"The earth-closet system will answer, in a restricted sense, where nothing else is attainable. So also may the Chinese tanks. But I entertain no doubt that they may be considered as secondary and imperfect contrivances, applicable only where sewers *cannot*, for some special reason (generally monetary), be constructed.

"I shall be very glad that you should make any use of this letter that you think fit.

"I am, ever yours truly,

(Signed) "H. ACLAND."

Dr Acland's opinion is a fair summary of my own, and I have frequently had occasion to put it in practice, by advising, orally, or by letter and drawings, &c., the fitting up of earth-closets in garden outhouses, detached dwellings, and small country places where good sewerage did not exist.

On the whole, it may be said that the opinions expressed by Drs Parkes and Acland are the best exposition that can be given of the relative merits of the Water-closet, and of the only other appliance which, in the most distant degree, approaches it in efficiency, viz., the Earth-closet.

In the particular case before us—that of Glasgow—I feel warranted in saying that not one of the gentlemen who have been referred to by Dr Fergus, nor any other gentleman who may be named, and who holds at the present moment a position as a sanitary authority, will be found to give his support to such a wild project as that of suppressing the water-closet system in Glasgow.

It is therefore abundantly evident, that if the citizens of Glasgow "follow the leading of the highest sanitary authorities," they must continue and *extend* the use of water-closets, and connect them with the sewers. But how shall they dispose of the sewage? Not into the river. That proposal I will not debate, so certain am I that, although the formal decision may be delayed, it is virtually a settled question. I will only interrogate another sanitary authority—one of the greatest names in modern medical science, whether considered as an original investigator, a practical physician, or a sanitary apostle—Dr W. B. Richardson, who, among other positions favourable for the acquisition of *special* knowledge, was for some time editor of the *Journal of Public Health*. In a lecture* delivered before "the Congress on the *Sewage Question*," at Leamington, October 25, 1866, he says, "I have only one other subject to treat of. Perhaps you will consider it the most telling. It is the question—What is the best way to apply sewage to avoid the propagation of these poisons? [viz., typhoid or gastric fever, cholera, &c.] Putting aside economy, I think there can be no doubt that *that town would be most happy in regard to its health*,

* On the Poisons of the Spreading Diseases. London: Churchill. 1867.

that should have *a proper water supply, derived from one source*, and *a drainage well flushed*, but not over large, and *a conduit to take away, as it is produced*, every particle of sewage into the sea. I am not speaking of the economy question at all. I am speaking of the HEALTH QUESTION. *The town thus placed*, would, I say, be A MODEL TOWN."

V.—MISCELLANEOUS ANNOTATIONS.

(*a*) *Erroneous Notions regarding the Production and the Accumulation of Sulphuretted Hydrogen.* (Page 10.)

Sulphuretted hydrogen is the most deadly of the gases that result from the putrefactive decomposition of animal matters. Thenard and Dupuytren found that 1 part in 800 of atmospheric air killed small birds in a few seconds. Chaussier found 1 part in 250 was fatal to a horse. More recently, Dr Barker has shown that 1 part in 2100 was almost invariably fatal to birds—1 part in 1800 was certainly fatal; 1 part in 200 killed dogs very speedily, and 1 part in 500 as certainly but more slowly. Dr Letheby finds 1 part in 500 soon fatal to rabbits. Orfila, and other observers, have recorded the fact that this gas also kills by its action through the skin, and that rabbits, ducks, &c., have died within a few minutes after having their bodies (the head excepted) immersed in a vessel of sulphuretted hydrogen. When introduced directly into the blood, the effects are still more powerful; and Weber has lately shown that two drops of a saturated solution of the gas in water injected into the crural vein killed a rabbit instantly, three drops killed a small cat in six hours, and a large cat died after the injection of four drops. The thoroughly reliable character of these facts has been corroborated by many competent observers.

It is, however, well known that, though poisonous as a gas when introduced directly into the lungs or blood, it is one of those gases which is perfectly harmless when taken, dissolved in water, into the stomach—*e.g.*, in Harrowgate or Moffat water, or carbonic acid in Seltzer water.

The deadly potency of sulphuretted hydrogen makes it a matter of so much importance that the closest heed should be given to the statements which may be, and frequently are made, regarding the alleged presence of sulphuretted hydrogen in any situation where it can possibly be supposed to affect the health of individuals. I have known several instances of assertions regarding this gas causing exaggerated and mischievous inferences in connection with questions affecting the public health. In one case, the Dumbarton churchyard inquiry, a professional witness stated that "sulphuretted hydrogen was the most noxious gas *which escapes from graves*." And he believed, and stated his belief, that he had demonstrated the evolution of the gas from the surface of the soil of the churchyard. To combat this evidence, Professors Anderson and Penny, and myself, made careful experiments on the surface of the soil—on the fresh soil of newly-opened graves, and on the air of coffins freshly opened, and the results, as regarded the evolution of this gas, were entirely negative. In another instance, that of the old Hamilton churchyard, Professor Penny

and myself had (by permission) numerous graves and coffins opened, and being provided with suitable appliances, we made experiments on the instant, and afterwards in the laboratory conducted careful observations on the soil immediately adjacent to the coffins, and on matters contained in the coffins, with entirely negative results as to the presence of sulphuretted hydrogen. In these instances, the animal matters had been in a state of decay for periods varying from three weeks to several years. While giving evidence at Dumbarton, much surprise and some incredulity were manifested, especially when it was stated that Dr Waller Lewis had, in 1849, inspected from fifty to sixty vaults and catacombs in London, and examined the exteriors of 22,000 and the interiors of 100 coffins, the interments having varied from weeks to centuries, and yet he was unable to discover a trace of sulphuretted hydrogen, except in one instance, and it was so faint that he had some doubt whether it came from the dead bodies. I have frequently applied tests to the atmosphere of dissecting-rooms, and invariably with like negative results. On several occasions I have found it necessary to correct the popular notions which exist on this subject, particularly in connection with "nuisance" cases.

The mistaken view and the false inferences arise from a want of sufficient consideration of two points—1*st*, The *quantity* of this gas that *can* be formed from decomposing animal matters; 2*nd*, The quantity that is *capable of collecting*, or that is ever *found accumulated* in any situation *where atmospheric air has access*, or where there is running water. It seems not to be sufficiently well known, that *sulphur is an elementary substance*, of which only a very *limited quantity* exists in the human body, or in its excreta. If, therefore, all the sulphur in the human body, or in its excreta, could enter into combination with hydrogen, and form sulphuretted hydrogen, it would still be a small and a definite quantity. Much of it, however, combines with oxygen, and it has various other combinations not disengaged as a gas, many of which are quite harmless in relation to health. Nevertheless, the gas is formed, and in considerable quantity, during the ordinary putrefactive decomposition of animal matters; but it does not *accumulate* wherever it has access to the three great sanitary agencies of earth, air, and water. Earth absorbs and decomposes it; running water dissolves and carries it away; and in air it is *diffused* with such wonderful rapidity that a cubic inch of the gas liberated in an apartment forty feet square can be detected almost instantly on the moment of liberation. It ranks as one of the most diffusible of the gases. It is very little heavier than common air. Owing, therefore, to its light specific gravity, and to its extraordinary power of diffusion, it cannot accumulate to any great extent in situations where atmospheric air has moderately free access.

It can, however, be extricated suddenly in large quantities, as in the opening or cleaning out of the *fosses d'aisance*, where, along with other gases, chiefly carbonic acid—the latter a heavy gas, not readily diffusible, and easily accumulating—it is occasionally disengaged with such rapidity that the miserable workmen employed in the disgusting labour are stricken down by these gases as if by prussic acid, and die asphyxiated. This form of accident is called *plomb*, and the precautions required

against its occurrence are, in Paris, under police surveillance, and are numerous and stringent.

Unless, therefore, under exceptional circumstances, sulphuretted hydrogen does not accumulate in a poisonous degree in situations where atmospheric air has moderate access. Owing, however, to the observations of Parent-Duchatelet, a contrary impression prevails, and there is found in many of our best text-books statements (chiefly based on his authority) to the effect that the air in sewers can contain, and usually does contain, 2 to 3 per cent. *or more* of sulphuretted hydrogen. In 1823, G. de Claubry analysed air from a sewer, and he gives a per centage of 2·99—say 3 per cent. of sulphuretted hydrogen. This seems to have been his first analysis, and in this same year he made another, which gave a result of 0·90, or 9-10ths of a per centage. All his other analyses were made six years later—that is, in 1829, during which year he made 19 analyses of the air in different sewers. In one case he found sulphuretted hydrogen in the proportion of 1·25 per cent.; in two instances he found 1 per cent.; and in the 17 remaining cases the amount did not reach 1 per cent., but varied from complete absence of the gas to 0·95 per cent. If, therefore, this exceptional analysis of 3 per cent. is excluded, and if an average is made of the remaining 20 analyses, I find the amount to be 0.81, a result which corresponds exactly with that obtained by Dr Letheby when he subjected sewage to conditions which favoured the greatest possible evolvement of the gas (see p. 34). In the presence of atmospheric air, as Dr Letheby's experiments show (see page 35), sewage evolves *mere traces* of sulphuretted hydrogen. Regarding G. de Claubry's, or, as more frequently quoted, Parent-Duchatelet's experiments, Dr Christison remarks that "they are scarcely so precise as those of his predecessors;" while Dr Letheby inclines to think that the means which were at the disposal of De Claubry and Duchatelet "were not sufficient to determine the actual proportion of the mephitic gas."

There is, however, another explanation to give of this remarkable per centage of sulphuretted hydrogen, which, as erroneously stated by many British authors, is usually found in the atmosphere of sewers; and it illustrates the facility with which false inferences may be perpetuated in our manuals or text-books by the frequent practice of one author copying the statements of his predecessor, instead of resorting to the original source of information.

Parent-Duchatelet was the secretary or reporter of a scientific commission specially appointed to devise measures for the "cure" of a gigantic *cloaca*, called the Amelot sewer, which had become choked up—had inundated the neighbourhood—and, in the fruitless attempts to clear it out, had caused the loss of several lives. Duchatelet, having observed that the workmen sustained no injury under ordinary circumstances, even when "altogether immersed" in the atmosphere of the sewers, suspected that when serious accidents did occur, they must have their origin in some *sudden development* of the gases caused by *stirring up* the decomposing masses. He was then only entering upon the investigation, and he resolved to test this point by *a special experiment*. He accordingly selected *the very worst part* of the sewer, where the accumulation was greatest, and ventured on a ladder into the pit (20 feet deep),

and remained two or three minutes, suffering only a difficulty in his breathing. He then withdrew, and made his arrangements for collecting samples of the gases "without risk." He had a special apparatus, which was suspended by a cord and lowered into the pit. Then, "instead of contenting himself with collecting the gases at the surface, in the manner that was followed in the case of the other analyses, he *stirred up* and *agitated strongly* the matters with the leg of a very long ladder, and it was *only when the disengagement of the gases had reached the greatest degree of intensity* that he filled the flasks, by the aid of the special apparatus, which held the flasks as close as possible to the surface of the matters from which the gases were disengaged."

The air in the flasks was then analysed by his colleague, De Claubry, who conducted the chemical part of the investigation, and it was found to consist of—oxygen, 13·79; nitrogen, 81·21; carbonic acid, 2·01; sulphuretted hydrogen, 2·99.

The report proceeds—"Such a difference merits the most serious attention, and *shows the cause* of the accidents which our workmen sustained. . . . . The oxygen was diminished in a *frightful proportion*—our other analyses showed at most one per cent. of sulphuretted hydrogen—here we found three per cent., *an enormous proportion*, . . . little more than what is necessary to destroy in an instant not only the strongest man, but even the strongest horse."

In the course of the official report various references are made to this exceptional experiment, and to the fact that there was "no ventilation" in the sewer, &c.; and finally, to prevent any erroneous inferences, the analysis is placed separately from the others, and a farther analysis is given of the air in the same sewer at other times, and which is as follows:—Oxygen, 78·07; nitrogen, 18·01; carbonic acid, 2·03; sulphuretted hydrogen, 0·09.

The *result* of this special experiment, surrounded by so many exceptional qualifications, has, however, been handed down by one writer to another, not only without a hint that it was obtained by exceptional means, but with a bare simplicity of statement that it is the *common* or *usual* state of things *in sewers!*

The fact that rats and mice were found thriving in the sewers to which Duchatelet refers, and in which, he says, workmen were able to labour—while, as we know, the same animals, and men, exposed elsewhere to the effects of the gas in question, in proportions very much less than three per cent., are speedily killed—has led some close observers to question the accuracy of the analysis itself. The mischief, however, has arisen entirely from erroneous statements of the nature of the experiment, just as there was an erroneous representation of Dr Letheby's experiments (page 10), and from these early errors, or misrepresentations, a shoal of authors have scattered broadcast the germs of dangerous practical conclusions.

The knowledge I have long had of the facts referred to—regarding the actual properties of the gas, and of the mistaken notions that prevail regarding the amount that is usually furnished from decomposition of animal matters, or that accumulates in atmospheres—caused me to suspect the accuracy of Dr Fergus' Table; and apprehension of the mischievous inferences to which the exaggerated statement

might give rise was the motive that induced me then, and induces me now, to direct special attention to the quantity of this gas that exists in sewers of the worst kind. In Glasgow sewers (see p. 14 *et seq.*) there can only exist "mere traces."

Dr Parkes says, and I concur in his common-sense view, "What is wanted is *to know the limits of impurity*." This I have endeavoured conclusively to show.

(*b*) *It is in those Localities that have no Sewers that we find Disease most active.* (Page 21.)

Water, which has served all the uses of a household, becomes filthy from the rinsings of animal and vegetable food, the washing of articles of clothing, necessary personal ablutions, &c. Where there are no sewers, the liquid impurities of the household are cast out from the dwelling. The paved ground and open drains are, in consequence, rarely dry, but, on the contrary, are generally wet and soaked, and in puddles from the "slops." The invariable companion of this "gutter drainage" is the abominable "*midden-stead*," and into it the ashes, night soil, and all other solid refuse, both animal and vegetable, from the adjoining houses, is collected, and there it accumulates and decays. The ground underlying and adjoining the midden-stead is "excrement sodden," and its pernicious qualities are carried *downwards* with every rainfall percolating the earth in the direction of a "well," or, it may be, leaking into a service pipe carrying water supply. The noxious exhalations that are carried *upwards* by evaporation from these excrementitious matters contaminate the atmosphere, and the neighbouring inhabitants live in a really malarious climate. There exists, with such a state of things, many concomitants that lie in the way of domestic and personal cleanliness, and produce habits of carelessness which rapidly lower both the moral and physical conditions of a population.

I have long been satisfied of these truths, and at one period they were so forced upon my observation, that I had it in view to prepare a comprehensive treatise on the *morbility*—that is, the diseases which prevail among the poor.

From 1843 till 1849 inclusive, I acted as parochial surgeon, and had charge, at first, of a suburban, and afterwards of a central city district. The latter, although half a mile in length by a quarter in breadth, furnished fully nine-tenths of all the diseases of an endemic and epidemic character from an area of 280 yards in length by 120 in breadth. I have thus described this "disease preserve," with which I had long a daily and hourly familiarity.* "The locality consists chiefly of five or six narrow streets, and about a dozen of the dirty 'closes' or 'wynds' for which Glasgow has acquired a discreditable notoriety. *There are very few sewers, or gratings which conduct to sewers*, and the greatest *amount of drainage consequently takes place on the surface.* The receptacles for filth consist of large open dung-steads, with an open window, through which the refuse is cast, and in these places of deposit *the filth accumulates, till it is in such quantity as to necessitate the removal of a portion from want of space for further deposit.* The cases are exceptional in which regular

* "Observations on the Epidemic Cholera of 1848-9," by James Adams, M.D. Edinr. 1849.

arrangements are made for this purpose, and in all they are miserably inefficient. Thus, in three of the worst closes of the district, I occasionally observe a frail old pauper paddling about the principal dung-stead with a broom or shovel, and the entire sanitary operations of these localities are due to his solitary exertions, in return for which he receives the shelter rent free, of a wretched cellar in the neighbourhood.

"The supply of water is very scanty—a single pipe or fountain is made to suffice for one or more of these closes, and the trouble of going such a distance, as is required, in order to procure a supply, seems to be sufficient excuse for the people to restrict the use of this essential element to the narrowest limit compatible with necessity."

In this field of study, the more I saw of the diseases prevailing among the poor, the more strongly I was satisfied that good sewage and an abundant water supply were necessaries for healthy existence, and in connection with these sanitary requisites it became specially impressed upon me that the proportion of the diseases that in great measure are preventible—viz., epidemic, endemic, and contagious—as well as the mortality arising therefrom, was much greater among the poor than among the general population. I set myself to elucidate these and several other points in which I felt interested. I applied to the proper authorities, and obtained possession of a very large number of the old "registers," or "case-books," of the district surgeons, and, with the assistance of a hired clerk, I laboured constantly for fully six months in extracting and tabulating all the data these registers could furnish. I thus noted and arranged in various forms the details of upwards of 150,000 cases of disease, and in so doing, the localities of disease, the streets, closes, or tenements which gave the largest returns became necessarily very familiar, and from time to time I made special inquiries regarding some case or group of cases more than usually interesting. At length I came to the belief that a map showing the *unsewered spots* of the city would faithfully represent at the same time the localities of fever and of other forms of disease often endemic. Accordingly, I got a quantity of skeleton maps lithographed, and aided by some friendly coadjutors, I laid down the lines of many gutter-drained districts. This was a serious labour, for there was little reliable information at that time. The municipality had just been extended, and our excellent master of works, Mr Carrick, although very willing to aid me, was new in office, and only beginning that course of reconstruction and extension of the Glasgow sewers for which he has received so much deserved commendation in every quarter where the value of such labour is appreciated. It was, therefore, under the influence of this teaching that I formed my opinions regarding the effects of sewerage on a town population.

This is not the place to go into details, but I may refer to two sets of the kind of facts which serve to show something of the over-proportion of preventible diseases which affect the poor.

Of 103,136 cases of disease of all kinds occurring among the poor during the years 1838 to 1848 inclusive, epidemic, endemic, and contagious furnished 56,049 cases, and of these 51,068 consisted of fevers and bowel complaints. I can give no similar

information regarding the morbility of the better class of the population, but many facts show that there cannot be so large a relative proportion of the epidemic, endemic, and contagious diseases.

I have calculated from several sources the subjoined Table. It shows the per centages which deaths caused by epidemic, endemic, and contagious diseases bear to the total number of deaths resulting from all causes:—

		Deaths from all Causes.	Deaths per cent. in Epidemic, Endemic, and Contagious Diseases.
Selected lives,	Scott. Amic. Ass. Soc.,	695	18·7
English rural districts,	Registrar-General, ...	29,693	20·3
,, towns,	Do., ...	47,953	26·6
Glasgow, general population,	Dr Alex. Watt, ...	55,000	44·8
,, poor,	Dr J. Adams, ...	4,987	48·0

An observing mind will at once infer, from the results so broadly displayed in the above data, that the morbility and the mortality affecting different classes of the population are materially affected by different circumstances. Of course the same conclusion has been often reached by independent observers. I have, to the best of my ability, searched into the details of the data, and my conviction, founded on independent inquiry, is that in the poorest localities of a town there exists, with a view to *the general good*, a necessity for everything that can come under the name of cleanliness. The ignorance, faulty habits, and daily occupations of the poor are only too apt to render them insensible to the physical advantages of the golden maxim, that cleanliness is next to godliness. Unless there is good water supply for necessary use, and an easy and inoffensive mode of disposing of the water after use, there cannot be cleanliness. It would be irrelevant to discuss the immediate causes of fever or diarrhœa, or the various diseases that advancing medical science is inclining to term *preventible*. It is sufficient to affirm that a gutter-drained district—a district that has no sewers carrying off, by the cleanly agency of water-carriage, the solid excrementitious matter of the population is a district of malaria—that the health of its indwellers becomes deteriorated—the vigour of their bodily constitution becomes lowered, and a condition of the general health is produced that disposes the organism to receive the impressions of certain *very common*, *very deadly*, and *very spreading* diseases.

The hardships which the poorer class—living under a municipal rule that tolerates the midden-stead and cesspool—have to bear are unquestionably very grievous. At this moment I call to mind many instances of the aged and infirm decent poor, who for years could rarely descend from the upper flats of the tenements where they had their abode, and who had very scanty aid from relatives and neighbours in maintaining in some degree a cleanly house and a pure atmosphere; and I review the terrible disadvantages under which many wives of operatives, mothers of growing families, maintain a struggle to preserve some measure of decency in their household arrangements. In times of sickness, in inclement weather, &c., how hard

is their lot, and how great are the obstacles they encounter in the preservation of conventional morality and habits of common decency.

I am quite unable to see why water-closets should be considered unsuitable in any well-sewered district, with abundant water supply. They may get out of order, like other arrangements, and they require supervision, just as the common latrines. There are various modes in which they may be modified to suit special localities. In any form, and in any locality, they can be made a nuisance. I am informed at the present moment of a discreditable state of things existing in costly premises within a few yards of the New Club, and I know that like exceptional instances may be found anywhere. The poor who live amid these unfavourable conditions have, however, very little ability to alter their external relations. It is, therefore, obviously the duty of those having better knowledge and unblunted instincts to exert themselves for the removal of the obstacles which lie in the way of the maintenance of the personal and domestic cleanliness of those who are ignorant and lack the power. In so doing, they will be acting in accordance with the Christian precept, "Love your neighbour," and they may rest assured that they are thereby best securing their own personal advantage. There is in a civilised community no real division of interests. We are all liable to suffer from each other's maladies, and have, therefore, a direct interest in each other's wellbeing. The physical ailments that are the lot of the ignorant and unprovided poor filter through a thousand unperceived channels from the abode of Lazarus to the mansion of Dives.

There has not been at any time in Glasgow a want of public spirit in meeting the burdens of sanitary improvements, but until a comparatively recent date that spirit was only awakened to action under the stimulus of public alarm. With other medical men, I have, on several occasions, shown that these measures were erroneous in principle, and that "so long as the practice and hygienic measures of our public men" are not guided by intelligent counsel, "so long will their personal energies and their influence be withheld from devising and carrying into effect other remedies which are better calculated to *prevent disease*, or at least to overcome those causes which are known to foster its growth, and aid very greatly its extension." I have said, "I place no value whatever on those superficial measures adopted during the temporary excitement which occurs during times of epidemic sickness. No medical man of experience in the condition and diseases of the poor, whose opinion I have obtained, considers that the bustling proceedings I allude to, in the way of lime-washing, fumigating, burning of old clothes and straw-beds, &c., effect any real benefit in preventing or breaking the force of the epidemic. . . . These measures may have the effect of allaying the apprehensions of that timid portion of the public who have least cause of fear, by giving colour to the usual newspaper announcements that the 'authorities' are fully alive to the emergency, and are adopting all necessary precautions,'" &c. When, however, the alarm has passed away, I have shown the generating influences that are permitted to remain, such as "the dark, damp, filthy, and noisome labyrinths of narrow wynds and deep

courts," "without sewerage or water supply" requisites, "the want of which in large towns is incompatible with healthy existence."*

This was the state of things at the period to which I am referring, but I am happy in having the opportunity of stating—from personal verification of the fact—that much of what I have described as existing in the district of which I had experience (and the same description applies to many others) has passed away. In a steadily progressive manner, changes are being effected in the poorer districts of the city, the necessity for which was long recognised, and called for by numerous eminent medical men of Glasgow, who have given heed to its actual condition, and to its shortcomings in relation to sanitary requirements.

In any measure designed for public improvement, it is not at all times easy to ascribe the true credit of the initiative; but it is the fact that, during the *regime* of our last Chief Magistrate, an officer of health, Professor Gairdner, was appointed, and, under his guidance, the changes referred to are taking place. The public prints have recorded the name of Provost Blackie, and that of Councillor Ure, among those of our leading municipal authorities who have steadily, and in an appreciative spirit, supported the measures devised by that public officer; but it is only those who can contrast by personal experience the state of things that formerly existed with our present stages of progress who can understand how much the thanks of the citizens are due to these men.

(c) *Noxious Gases and Organic Poisons.*

The general public are often perplexed and led into serious error in consequence of not recognising the great distinction that exists between the effects produced by *gases of known composition* and by the *organic* poisons.

Among other modes of production, some of these *gases* are the results of the decomposition of sewage matter, viz., carburetted hydrogen, carbonic acid, sulphuretted hydrogen, &c. Exposure to the concentrated action of these gases will kill by poisoning speedily, or within a few hours, or after a lapse of days, just as certainly as prussic acid, or laudanum, or arsenic will kill by poisoning. If the gas does not immediately *poison*, or if it has not been imbibed in a fatal dose, the individual begins to recover as soon as he is removed from continued exposure; and whatever may be his symptoms or his sufferings, these cannot be *communicated* to another person.

The mode of action of the organic poisons—about fifteen in number—is altogether different. Small-pox, typhus fever, and glanders furnish good examples. The individual who suffers from their effects exhibits a series of symptoms following a regular course, subject to modification according to the severity of the dose, state of bodily habit, &c. These symptoms constitute *disease*, which, in the case of most of the organic poisons, and probably of all, is *communicable* from the person affected to another in health.

* Results of the Treatment of Fever in Glasgow Hospitals and Out-door Practice Contrasted. James Adams, M.D., Edinburgh. 1850.

The essential distinction, therefore, is, that in the one case—that of the gases—the symptoms diminish gradually, and pass away when the individual is removed from the gas; while in the other—that of the organic poison—the symptoms go on developing from the time the poisonous dose is received. The symptoms produced by the gas can never be communicated from one to another individual. The symptoms produced by the organic poisons can be, and frequently are, communicated to other individuals.

The best knowledge we possess of the nature of these organic poisons has resulted from the experimental investigations of Dr W. B. Richardson. As regards their special properties, they are all separable, and Dr Richardson has separated some of them—*e.g.*, hospital fever. In the course of some diseases, as small-pox, they are separated by nature in an almost pure state. Dr Richardson says—"We can take certain of these organic poisons *from the body*, reduce them to an extract, and from that extract produce a purer substance containing the true poisonous matter. This may be then communicated to another animal, and will give to the body of that animal the same poisonous property as was possessed by the poisonous substance first introduced. Again, the poison can be passed on and made to affect another animal, and so through a series of subjects. . . . . I may state that *all the organic poisons are perfectly inodorous*, have no smell whatever, and that *no communicable disease ever depends upon the gases of decomposition*, viz.—carbonic acid, sulphuretted hydrogen, ammonia, phosphuretted hydrogen, or carburetted hydrogen."

Regarding the properties of gases or polluted atmospheres, I might refer to many observers, but probably to none who have given the subject more careful consideration, based upon original research, than the late Dr R. D. Thomson. In his "Report on the Examination of Certain Atmospheres," furnished to the Board of Health in 1855, he says:—"There are no facts with which we are acquainted having any tendency to indicate that the respiration of vapours is capable of producing a disease characterised by a regular type, or that gases act physiologically otherwise than as dilutents of oxygen, or, as simple poisons. Neither is the evolution of gases alone from organic matter calculated to induce such diseases of endemic nature as are recognised by a regular sequence of symptoms. . . . . The products of putrefaction of an elastic gaseous nature are not the chemical substances most to be dreaded in the production of disease. . . . . It is the fresh, undecomposed matter which is alone capable of propagating the noxious influences in the instances to which allusion has been made; and any agent which interferes with the integrity of the morbific molecule destroys its capability of inducing a regular disease. . . . . The practical bearing of this conclusion is, that we are not to expect any information respecting the morbid condition of the air from experiments on a small scale upon the chemical constitution of the normal gases in any given atmosphere, or even on the minute traces of abnormal gases, which may be detected by the most delicate appliances of science."

To destroy the poisons, either organic or gaseous, the best antidote will be found in the great natural sanitary agencies of air and water. Referring to organic

poisons, Dr Richardson has found that "as we progress in diluting them with water *they entirely lose their active power.*" The effects of free exposure to air in modifying and destroying the noxious action of gases disengaged in respiration, combustion, and chemical manufacturing operations are so familiar as to require no illustration, but I am tempted to give one because of its direct bearing on the present discussion. I quote from Dr Richardson :—"The influence of the poisonous gases to which I have referred does not differ very widely from the influence of chloroform, or of any volatile bodies which produce sleep. Dr Barker of Bedford most conclusively shows that the mere noxious exhalations from sewers produced only temporary effects. Dr Barker carried out a series of experiments which we may call crucial. He made a chamber to hold live animals of large size. This chamber was ventilated from a sewer, and week after week animals were made to breathe the sewer air. These animals all showed peculiar symptoms—something like the symptoms which we see in the close cottages of the poor during the winter time, when there is great overcrowding and a great accumulation of bad air. They sometimes showed symptoms of vomiting; they had heat of skin, quick pulse, and loss of appetite; but this was invariably the fact—that within an hour after their removal from the chamber they began to recover. The symptoms were from the distinct effect of the air from the sewer, and had nothing to do with the organic poisons which produce specific disease."

From what has been adduced to show wherein the real danger lies, the general reader will concede that I was justified (p. 9.) in stating that undue weight is often attached to the names of chemical compounds when used in connection with sanitary questions; and he will understand how very small may be the result, even when attained, of the fussy, costly, and practically inoperative appliances that are eagerly vaunted for removing the *smell* from sewage matter; and he will better appreciate the danger of permitting "filthy facilities" for such matters, even when *deodorised*, remaining within or about the precincts of our dwellings.

(*d*) *The Mechanical Detail as to the proper mode of connecting Water-closets with the Sewers.* (See pages 7, 29, and 45.)

Although thoroughly aware of the fact, that there is no difficulty in having proper arrangements which will prevent the reflux of unpleasant emanations from drains and sewers into the interior of our dwellings, I have deemed it advisable to have the statement from a thoroughly competent authority, and therefore subjoin a letter from Mr Robertson, C.E.:—

123 St Vincent Street,
Glasgow, 30*th November*, 1868.

My Dear Dr,—In reply to your inquiries made a few days ago, as to the ventilation of the drains and soil-pipes in houses, I have to state that the lead soil-pipe, into which jaw-boxes and water-closets in the several flats of a tenement discharge, is a vertical continuation of the fire-clay pipe-drain from the street sewer to

the house, and it terminates with an open end above the ceiling of the upper flat, or in the open air. Between the street sewer and the house the pipe-drain is trapped, to prevent vermin and gases passing into the house from the sewer; and the several branches from the jaw-boxes, water-closets, or bath-rooms, are also trapped, so that none of the gases or vapour, even in the soil-pipe, *can escape* into the house.

These are the arrangements made in all *properly drained houses;* but I have no doubt you will find many *exceptions* to it in Glasgow and elsewhere.

Yours truly,

WILLIAM ROBERTSON.

Dr J. Adams, 62 Cambridge Street, Glasgow.

(*e*) *To the Editor of the North British Daily Mail.*

Sir,—A letter from Dr Fergus in this day's *Mail* on the "Sewage Question" contains the following passage:—"'J. A.' says that the second essayist showed that the data on which the essayist (Dr Fergus) based so much of his conclusions were 'erroneous, delusive, and unsubstantial.' Now, the fact is, I quoted Dr Letheby from Dr Parkes' work on 'Practical Hygiene,' and at the close of the meeting Dr Adams shifted the responsibility from my shoulders to his (Dr Parkes'), Dr A.'s own assertion being the only proof brought before the Society that Dr Parkes was in error."

There is here a mixing up of varied occurrences, and a challenge for proof that can only be put right by a publication *in extenso* of what I actually did say on this subject. Pending this publication, which will be as speedy as circumstances can allow, I request you will do me the favour to give place to the following statements, the object of which is to keep clearly before the minds of those who take an interest in this controversy the issue that has actually been raised:—

On the 2nd of October, Dr Fergus read a communication to the Medico-Chirurgical Society, and exhibited a Table containing certain data, or alleged facts, on which he mainly based his conclusions, regarding the relative composition, quantity, and quality of gases generated in sewers. He attached the name of Dr Letheby to this Table, and stated that he was its author. No remarks were made at this meeting, the discussion being simply adjourned. At the following meeting I opposed his argument, and, *inter alia*, stated that the Table bore on its face such palpable error that I was certain it could never have been issued by Dr Letheby, whom I knew to be accurate and reliable; that, accordingly, on turning to Dr Letheby's works, I had ascertained that this Table had no place there, and that it must therefore have been made up by Dr Fergus himself, or by some one whom he had too implicitly trusted, from data which he had altogether misapprehended. Those statements I then and there satisfactorily proved. This I think, and this I affirm.

At the close of the debate, and when winding up the discussion in his reply, Dr Fergus explained that he had not named Dr Letheby as the author of the Table on the authority of Dr Letheby's own writings, but had copied at second-hand from

a work by Dr Parkes. I thereupon, animated with a kindly feeling, willingly conceded that the statement, now for the first time made, showed that the Table had not been made up by Dr Fergus himself, but, as I had previously suggested as an alternative possibility, by another person whom he had too implicitly trusted. The illegitimate use made of this concession constrains me now to point out the exact extent to which the responsibility has been shifted by me from Dr Fergus' shoulders. The builder who is charged with having erected an edifice upon basement-timbers that are thoroughly hollow and rotten may have his explanation willingly admitted when he states that he himself did not grow the wood nor dress it into shape. But this does not shift from his shoulders the responsibility of having selected and used the material. By this illustration I mean to declare that my admission of the correctness of the alternative I had with confidence predicted—viz., either a blundering compilation by Dr Fergus himself, or by some one he had implicitly trusted—does not, in the very smallest degree, relieve Dr Fergus from my criticisms on his argument, which, being mainly based on the data or alleged facts professedly furnished by the Table referred to, necessarily partakes of the error, and vitiates all the conclusions derived from it.

But Dr Fergus still, to my amazement, maintains that there are no errors, and that my own assertion is the only proof I have given of these errors. There is, therefore, now a necessity for the publication of my proof *in extenso*, and this I now promise.

It will show to the most limited capacity, as I hope, that Dr Fergus could not possibly have given a more unfortunate illustration for himself than when he says that my position reminds him of a party "who, being told that facts were against him, got out of his difficulty by exclaiming, 'So much the worse for the facts.'" He who makes use of data (*i.e.*, alleged facts), unless he puts forward the caveat that he takes them upon trust, makes himself responsible for their accuracy, the more especially if he comes to conclusions which only the accuracy of his assumed data can warrant. If the alleged facts are against him, and yet are no facts at all, then so much the worse for the facts, or rather for the man who constructs his whole theory upon them.

I am, &c.,

JAMES ADAMS, M.D.

62 Cambridge Street, *Nov.* 2., 1867.

GLASGOW:
PRINTED AT THE CITY STEAM PRINTING WORKS, ANN STREET.