SECTION III.

CHEMISTRY, METEOROLOGY, AND GEOLOGY.

ADDRESS,

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President of the Section.

Although having to preside over a section that includes three sciences, I must, at the outset, express a hope that no one will expect me to be three single gentlemen rolled into one, able to discourse on chemistry, on meteorology, and on geology. Rather must I follow the advice given to the cobbler, and stick to the last.

I may, however, claim some little connection with all the three branches of science, and it behoves me perhaps to make the most of this. The first of them, chemistry, was the first science that I studied, and once (a long time ago) I thought myself the happy possessor of some fair amount of theoretical knowledge of it. Since then, its language, and one may say its alphabet, has changed; and I should be very sorry to have to undergo an examination in its rudiments now-a-days.

Having led more or less of an outdoor life for nearly thirty years, I may be allowed to have some practical interest in meteorology, as well perhaps as a certain amount of weather-wisdom got by experience and by rough observation.

And here let me put in a plea on behalf of a much abused institution—our English climate, which I am disposed to look on as a fairly satisfactory arrangement; perhaps indeed it would be quite satisfactory if our American friends would leave us alone, or would treat us more justly, by now and then sending us some fine weather instead of always bad. It should be satisfactory to know that much of our bad weather is not a home product, but an importation. To those who would bask in perpetual sunshine, to my mind a most unpleasant way of

spending time, I would quote the words of Charles Kingsley, in his "Ode to the North-East Wind," giving his views of the relation of weather to health, which perhaps are not too well known to meteorologists:—

Welcome, wild North-easter!
Shame it is to see
Odes to every zephyr;
Ne'er a verse to thee.

* * * *

Tired we are of summer,
Tired of gaudy glare,
Showers, soft and steaming,
Hot and breathless air.
Tired of listless dreaming
Through the lazy day:
Jovial wind of winter
Turn us out to play!

* * * *

Let the luscious South-wind
Breathe in lovers' sighs,
While the lazy gallants
Bask in ladies' eyes.
What does he but soften
Heart alike and pen?
'Tis the hard grey weather
Breeds hard English men.

As for geology, the last-named science of our section, it is also the last science that I took up. It has since been my study, continuously, for some thirty-two years, and I am beginning to despair of ever knowing very much about it; for its bounds are ever extending, and at such a rate that the ordinary human mind cannot keep up with it. Indeed, geologists have long been obliged, with comparatively few exceptions (of which I am certainly not one) to limit themselves to certain branches of their science. In my own case some of the more practical bearings of geology have been forced on my attention, by the more or less mechanical nature of much of the work that has fallen to my lot as an officer of the Geological Survey—work that consists essentially of recording facts, or, at least, of doing one's best in that way, some of her facts being much hidden by Dame Nature.

It has been my duty at times to work with Medical Officers, and this duty has been a pleasure also; for it is pleasant to find one's own particular science of use beyond one's own immediate sphere of action. One of these occasions may fairly be alluded to here, as an example of the bearing of geology on large problems relating to questions of health; in this case to the distribution of certain diseases in certain districts. I refer to the enquiry made by my old friend and fellow-student in geology, Dr. G. Buchanan, now the chief Medical Officer of the Local Government Board, on the Distribution of Phthisis as affected by Dampness of Soil. Having had to report on the effects of sanitary work in certain large towns, Dr. Buchanan unexpectedly found that where, from improved drainage, a decrease of subsoil water had taken place, there the consumption death-rate had also decreased, the most marked example being Salisbury, where the decrease was to nearly a half.

This result led Dr. Buchanan to think that, as artificial drainage caused so great an improvement, it might be found that in districts where, from natural causes, the subsoil was less saturated with water, the death-rate from consumption might be less than in districts where greater saturation occurred.

The further enquiry that was made for the purpose of testing this important question of course involved the examination, in some detail, of the surface-geology of the district selected, as being the one in which alone (at that time) we had the materials for such a work. This district included the whole of the counties of Kent and Surrey (leaving out London), with great part of Sussex, and the enquiry resulted generally in the conclusion that wetness of soil and prevalence of consumption go together.*

Two of the chief problems in matters sanitary are to get good water and to get rid of bad water. Indeed, one may say that when these problems have been solved in any town, at least two-thirds of the work of sanitation have been done.

Our aërial friends may perhaps object to this, and may say that I should be contented with a half, air being of equal importance with water; but I hold that the objection would be itself aërial, and for this reason, that the questions of good and of bad air go together: you cannot get good air without getting rid of bad air, though it is possible of course to replace bad air by other equally bad, or even by worse. With water, however, the case is quite different: a town may have one of the best of water-supplies, but its bad water, that is its sewage, may be got rid of

* For full details see Tenth Report of the Medical Officer of the Privy Council, pp. 57–110 (1868); for a shorter account, from a geological point of view, see *Geological Magazine*, Vol. vi. pp. 499–505.

in the worst way; and, on the other hand, another town may have the most complete arrangements for properly getting rid of its sewage, or even for almost doing without that article, but may have a very bad water-supply.

Again, water-supply and sewage must be questions of a more or less public kind, in large places; whilst air cannot be publicly dealt with to any such extent, except as part of sewage arrangements, the ventilation of houses not being yet within the ken of corporate bodies.

With regard to water, it is not only important that populous places should, in the first instance get a good supply; but also that it should be kept good, or, in other words, that sources of pollution should be religiously kept away, a process that entails a careful watch on the doings not only of one's own corporation, companies, &c., but on those of one's neighbours' besides. Undoubtedly the worst thing that can be done with water and sewage is to mix them.

The importance of a good water-supply, and the evil that may result from a bad one, have recently been brought before us in a paper by Mr. G. Higgins,* which treats of the late outbreak of cholera in Spain, showing how its virulence went along with badness of water-supply, certain large towns having been but little affected as compared with others. The author's conclusion may be given in his own words:—"Broadly speaking, it would appear that in Spain this formidable disease never became truly epidemic or dangerous in any city in which there was a pure and good supply of water." In illustration of which, six places provided with good water (in one case a bad supply having been suppressed) are noticed as comparatively free from the scourge, whilst others, with a more or less contaminated supply, were severely visited. So marked, indeed, is this that Mr. Higgins thinks that "when it (cholera) gets possession of the water-supply of a city, no bounds can restrain it; there is but one resource, and that is cutting off the water."

This lesson should be taken to heart by our local governing bodies, who should jealously guard our water from contamination, or indeed from any risk thereof. The immediate saving of money, so popular a notion with many of these bodies, is really a small matter as contrasted with the danger to public health, which may often follow in a not far distant future, from the acceptance of schemes for sewage, for cemeteries, or for other such contaminating influences, on the ground that they "save the rates." I may bring to your notice some schemes, which, originating either in this way or from a want of forethought

* Cholera in its Relation to Water-Supply, *Nature*, 17th June, 1886.

as to their possible result (sometimes indeed from want of knowledge at the time), show the truth of Hood's lines, that

"Evil is wrought by want of Thought
As well as want of Heart."

It occurred to me at first that it might be better to notice the following cases without giving the names of the places where they occurred; but second thoughts, which are proverbially best, suggested that a certain vagueness would result, which might decrease the effect of the whole. It is only fair to say that the cases brought forward are not meant as glaring instances of wrong-doing, actual or projected, some of them referring to comparatively trifling matters; but merely as examples of questionable proceedings of a kind that may often crop up and vex the sanitarian mind. They will be taken in the alphabetical order of the places of occurrence.

Barnet.—Twenty-one years ago an "Absorbing Well," was made for the sewage of New Barnet. It was foreseen that it would hardly do to carry this into the Chalk, the great water-bearing bed of the district, and it was ended in sandy Tertiary beds, between the London Clay and the Chalk. As, however, water is sometimes got from those beds, this proceeding is not without danger. Moreover, there is also the danger of there being some communication between those Tertiary beds and the underlying Chalk, from which the water-supply of the place is got. I believe, however, that this sewage-well has been abandoned. If not it ought to be.

Canterbury.—This city is blessed with a good supply of water from the Chalk, got near the southern boundary, and softened. Lately however, some houses, draining into cess-pools, have been built near by, but unfortunately outside the boundary, and therefore beyond the jurisdiction of the city. Whether any pollution of the water may result is perhaps uncertain; but no one should be surprised to hear that the Water Company has expressed its displeasure at the proceeding.

Fareham.—A somewhat remarkable case of water-pollution has lately been under investigation at the Hampshire Lunatic Asylum, near this town. A bad outbreak of typhoid fever led the Board of Visitors to have a thorough investigation made, and one of our Fellows, Mr. Rogers Field, has, I think, satisfactorily traced its origin to pollution of the water-supply. Having a fair knowledge of the circumstances, I may give a summary of the history of the case, premising that the Asylum was established many years ago, when Sanitary Science had hardly been invented, so that it is an example of the difficulties that authorities may meet with in old institutions:

1. A dry healthy site was selected on a low chalk hill, with a capping of gravel, and partly bordered by a stream.
2. A well was sunk, and a plentiful supply of good water was got at a moderate depth.
3. The sewage of the Asylum had to be provided for, and this was done, not unnaturally, by distributing it over parts of the grounds, all of which consist of Chalk, capped with gravel at the higher parts.
4. The hundreds of living lunatics in the Asylum having thus been cared for, it became essential also to think of those who died, and a Cemetery had to be established. This also is on the Chalk, and now contains more than 1,500 bodies.
5. The result of a careful investigation, from engineering, from chemical, and from geological standpoints, was to prove that the water of the well was contaminated (as might be expected), and it was shown that the underground flow from the neighbourhood of the cemetery and of the sewage-works was either naturally in the direction of the well, or had been artificially made so by pumping, which pumping, moreover, slightly affects the water-level in a piece of water further from the well than the polluting causes, proving that these are within the cone of exhaustion.

We hear much now-a-days of the germ-theory; but, as far as I know, it has not yet been extended to the propagation of madness; we have not yet heard of the *Bacillus* of lunacy. Should such extension be made, it would seem that the Asylum in question may bid fair to prosper, if increase of business means prosperity, until some other water-supply has been got, as, however, I have no doubt it will be.

Sutton (Surrey).—The Local Board of this place has lately brought forward a scheme for establishing a Cemetery on the Chalk, about three-quarters of a mile from the Waterworks, which get their supply from the Chalk. Strange to say, the Waterworks Company did not oppose the scheme (some ill-natured people said because some of the Directors are also members of the Local Board); but many of the rate-payers opposed it very strongly, being desirous of having water without risk of pollution. I have read the evidence that was given at a Home Office Enquiry, which is of course of the usual conflicting, and sometimes irrelevant, character, and was glad to find the voice of our member, Mr. Baldwin Latham, lifted up against the proposal, as one likely to cause pollution to the water-supply. You will be glad to hear that the Home Office has refused its sanction to the scheme, and perhaps surprised to hear that the Local Board has started another, of just the same kind, for the establishment of a Cemetery within half a mile of the former proposed site, and like it, about three-quarters of a mile from the Waterworks; but with the further advantage of being close to the large Metropolitan Schools, where some 1,500 children are supplied with water from wells in the Chalk. Perhaps a reduction in the number, by means of a possible epidemic, is looked on as a method of affording relief to the rate-payers of London.

One cannot help wondering what would happen were the Waterworks in the hands of the Local Board, and a Company proposed to establish Cemeteries on either of the suggested sites!

The question of burying-grounds leads one to ask whether it is right that the living should be sacrificed to the dead? Will there never be an improvement in our present horrible way of dealing with the latter? That subject, however, it is not my business to discuss;* enough to enter a protest against the establishment of cemeteries on great water-bearing formations, and near waterworks.

Swaffham.—One day when working on the Geological Survey in Western Norfolk, I had occasion to look at a certain chalk-pit within two miles of this little town, my interest in which was augmented by seeing, in the distance, signs of moisture in the bottom, where, from the height of the place, no such signs should be, the saturation-level of the Chalk not being near the surface. I hastened down hill to this quite unexpected occurrence, and suddenly found myself in ground soaked with moisture of a distinctly unpleasant kind! My nose (and most people can speak through the nose) said sewage! and I quickly evolved the theory that Swaffham drained itself into this chalk-pit, a theory that, unlike many others, survived the test of enquiry. Luckily this sewage-pit is not in the line of flow of underground water to the town, which is supplied from a well in the Chalk, and luckily, too, it is some way from houses. As, however, we know little about the distance to which sewage in bulk may flow underground with retention of polluting power, I look with some interest on the Swaffham experiment. Any one wishing to see this experiment will easily identify the spot, which touches a road, by scent.

Tring.—I will now allude to a case referring to surface water-supply, for information on which I am indebted to my colleague Mr. Jukes-Browne. Part of the drainage of this town is carried away by a sewer which empties itself into the canal-reservoir to

* It was the first subject discussed in Section I., p. 77.

the north. Before this sewer was made the reservoir received only spring-water, a matter of some importance, as some neighbouring villages drew their water from the stream that flows from the reservoir. After the turning in of the sewage, in summer, when the water in the reservoir was low, it stank abominably; and worse, diphtheria, typhoid fever, and other such diseases, were frequent in the villages. This has lasted for years; but I hear that the Local Board have at last adopted a scheme to treat the sewage by broad irrigation, on land between the reservoir and the canal, and that the process is to begin this month. Whether it will be perfectly effective or not may be a matter of doubt, and very likely the question of the water-supply of the villages may crop up again.

The course along which we have now gone can hardly be called a pleasant one. It is not, however, the object of this Congress to take you along such paths, but rather to show evil ways, and to lead to their improvement. Yet I would like to call your attention to a subject that will perhaps prove to be very important, and that, so far, shows that some processes in every day use in many waterworks may turn out to have a beneficial effect in a way never dreamt of when they were started. The processes alluded to are *filtration* and *softening*. The subject arises from a paper by Dr. P. F. Frankland, published only last July,* in which it is shown that filtration not only fulfils its object in separating solid particles from water, but also reduces the number of micro-organisms in the water, the reduction going even to the extent of entirety at the very first, but, in most cases, greatly decreasing after prolonged action. Iron-sponge and coke are exceptions to the great decrease in this power, and are by far the most effective substances. It is noteworthy that this power of stopping the passage of micro-organisms is possessed by substances that have hardly any chemical action on water. Of course, Dr. Frankland's experiments emphasize the need of the frequent renewal of filtering materials.

It is found too that micro-organisms are thrown down from water by agitation with particles of solid matter; and here again coke is to the fore, closely followed by charcoal and by chalk. If, however, the water be left long with the deposit thus thrown down, a re-ascension of organisms, and their consequent multiplication, take place.

A like purification is also brought about by chemical precipitation, a fact of great practical importance, such precipita-

* Water-Purification; its Biological and Chemical Basis. *Proc. Inst. Civ. Eng.*, vol. lxxxv., p. 197.

tion being conducted, on a large scale, in the process for softening water from limestones, such as the Chalk, by the addition of lime-water, causing deposit of calcic carbonate in a finely divided state. This process, strange to say, has a greater power biologically, in removing organisms, than it has in chemical purification.

The questions as to what harm micro-organisms may do in water—whether some are bad, some good, and some indifferent, and which are which—cannot be here discussed. They belong to another Section. One of our members, however, claims to have taken over 23 millions of them in 18 months, I believe with no evil result; but then he took them in hot water, which, perhaps, they may have relished less than he did, and it is not stated whether he took the water without accompaniment.

It occurs to me that this may be a fitting occasion to advance a plea for a certain set of scientific men: I mean those who often have to apply their science to practical purposes. Surely those who do their best to apply science to the public good are entitled to some credit, and should not be slighted, as there is sometimes a tendency for them to be, by those who, from various reasons, are enabled to follow the purely scientific bent of their own minds, to give up their time to the delightful pursuit of knowledge in the abstract, and, as it is often put, to study science for its own sake, which perhaps sometimes means that a man does what is pleasant to himself without particular thought of anybody else! Some applyings of science, on the other hand, are hardly likely to be to any one's taste, and, at all events, the ways of sanitary science do not always lead to pleasant places.

Again, I would ask—What is the use of knowledge? Is it merely to be looked on as educational—as improving the mind? Is not the body to be thought of? And is the proverb, *mens sanâ in corpore sano*, to hold only for the individual? Does it not apply to the body politic?

Great researches and discoveries are beyond the power of many of us—of nearly all of us. We cannot all start and establish great theories, largely affecting the progress of science; but we can all do some little to advance knowledge, and with careful observations of facts, followed by fair inferences drawn from those facts, we may help the generalizers of the future. We cannot all be Newtons or Darwins; but we can all do something for the good of our fellow-creatures.

Ald. Rowntree (York) moved a vote of thanks to the President of the Section for his address. The President had concluded by saying that we could not all be Newtons or Darwins, but he had shown that he had one point of similarity with Newton, and that was the great modesty that characterised his opening remarks, reminding one of Newton's observation of how comparatively little he knew. But as they had listened they had heard sufficient to show that the President knew a great deal, and a great deal which would be valuable to them all. They were all concerned in the purity of the water supply of their different localities. The citizens of York were interested in it. The history of their water supply was an interesting one, dating back two centuries ago, when it was drawn from the river and distributed in the city in wooden pipes—trunks of trees—which were still occasionally dug up in the streets. Writers on the health of the city last century had spoken of the distribution of the unfiltered water, and particularly when taken during a flood, of its thick nature, as one of the causes which injured the health of the city. The gradual improvement in the supply, the extension of the waterworks, the taking of the water from a greater distance, and then the application of filtering, had all acted beneficially on the health of the city.

Mr. S. W. North (York) seconded the vote of thanks, which was carried by acclamation, and acknowledged by the President of the Section.

On "Open Spaces and Physical Education," by Lord Brabazon.

"Civium Vires Civitatis Vis."

Of late years a marked increase has taken place in the number of Urban Parks, Gardens, and Playgrounds of the United Kingdom which are accessible to the public. This activity on the part of municipal authorities and of philanthropic Societies and individuals, is largely owing to the growth of a public opinion favourable to the creation of pleasant oases, refreshing to the mind and body, wherever the undue extension of bricks and mortar has banished man from the humanizing influences of nature, and has turned the soil into a stony wilderness. The credit of giving the impulse which set this public opinion in motion is due in a great measure to Miss Octavia Hill. She it was who in season and out of season was never weary of preaching, often to deaf ears, the importance of open spaces for the benefit of the poor, and especially of their children. She it was who first put into practice the principles she preached, and turned a fetid London court into an "open-air drawing-room." Her example has been largely followed. Within the short space of three years the Metropolitan Public Garden Association, through the generosity of the public, has alone been enabled to throw open to the people of London four playgrounds and seventeen gardens, and of these one of the former and one of the latter have been permanently transferred to the care of the local municipal authorities. This transference of open spaces, from the care of an Association supported by voluntary subscriptions to that of a public body like a local Vestry or District Board, means, of course, an increase (though an infinitesimal increase) of the rates, and there are those who, from not thoroughly appreciating the important issues involved in the matter, question the justice or the propriety of a public authority increasing the burdens of the people for what they consider to be a luxury rather than a necessity. Such a doctrine will find no support at my hands, even supposing these open spaces could be regarded as simple luxuries. I believe that there are luxuries of a public character, such as Museums, Art Galleries, &c., which the Government of a rich and prosperous nation is justified in providing for the benefit, refinement, and enjoyment of the people committed to its charge; but the question will arise, can Parks, Gardens, and Playgrounds—means for the preservation of the public health—be considered luxuries? Should they not much more justly be ranked among public necessities? Health is one of the first of these, and in my opinion no expense should be spared, and no opportunity neglected, to increase the average standard of the nation's health and strength. If a people's average standard of vitality be lowered, that people will assuredly be handicapped in the race of nations by as much as that standard has been lessened. The health of the mind is largely dependent on the health of the body; and although occasionally a powerful and healthy brain may be found in a diseased body, the mind and body act and react one upon the other. So that a nation (and it should be remembered that a nation is nothing more than the aggregate of the men and women composing it) will only have as much muscular power, and brain-force, as may be the sum-total of these qualities possessed by the men and women of which it is formed. A simple reference to the last census returns will show that this country is increasing at the rate of 300,000 a year, and that these 300,000 are not added to the country population, but are absorbed by the large overgrown cities of Great Britain and Ireland. Now it is a well-known and universally recognised axiom of hygienic science, that other things being equal, the health of a population is in inverse ratio to its

density; in other words, that the more the people are congregated together, the more unhealthy do they become. This being the case, it will be readily seen that *unless steps are taken to counteract the operation of this natural law, the inhabitants of our towns must degenerate in health*, which is as much as to say that this is the destined fate of two-thirds of our population; for at this moment there are in Great Britain two men living in towns for every one living in the country. Now what are the most obvious steps to be taken to counteract this natural tendency of disease to dog the steps of men when crowded together? Why, to open out the population as much as possible; or, if this cannot be done, at all events to break up these dense masses of humanity, by intercepting them wherever and whenever possible with open spaces. If this be the first remedy, then surely it is the duty of those who are the guardians of the public health to provide such open spaces? For individuals cannot be expected to buy them for the general good, and in no way, in my opinion, could public money be more legitimately spent than in thus preserving and improving the health of the community. I trust I have clearly shown that the providing of public gardens and open spaces in large towns is no question of ornamental luxury, but one very closely connected with the health of the people, and, as such, should be considered a most legitimate object for the expenditure of public money.

If it be right that the people inhabiting our large towns should be provided at the public expense with parks, gardens, and playgrounds, for similar reasons I think many will agree with me that, where possible, gymnasia should be attached to elementary schools, and that systematic instruction should be given to the children in gymnastics and calisthenics. The body should be trained as well as the brain. At present, our system is entirely a one-sided one. We starve the body and overwork the brain, and the former takes its revenge on us by refusing to nourish the latter. The brain, unable to bear the strain, which would be no strain if the body were properly cared for, frequently breaks down, and broken health ensues, followed sometimes by insanity and even death. Germany and Switzerland, as well as Norway and Sweden, have for long been alive to the necessity of caring for the body in order to get the best work out of the brain; and although the inhabitants of these states, being mostly country bred, are not in such urgent need of physical training as are the populations of our crowded towns, the sums expended by the governments of these nations on the compulsory gymnastic training of the young would appear incredible to the educational authorities of this country. Whilst

I have been writing, the physical aspect of the education of women has occupied the attention of the British Medical Association, and its President, Dr. Withers Moore, has been giving the following strong expression to a belief that women are suffering through over-pressure in brain-work whilst at school and college: "From the eagerness of woman's nature," says Dr. Withers Moore, "competitive brain-work among gifted girls can hardly be but excessive, especially if the competition be against the superior brain-weight and brain-strength of man." "They require," he asserts, "to be protected from their own willingness to study," and how, we may add, can they be better protected than by being encouraged to turn some of their energies towards the improvement of their physical natures by means of calisthenic and gymnastic exercises, or by healthy open air games suitable to their sex. In a pamphlet which has lately appeared, Mr. Alexander, Director of the Liverpool Gymnasium, discusses the provision in England for physical education, points out its inadequacy in every respect, and states what are the nature and extent of the required reforms. He maintains that there are many teachers in charge of existing gymnasia who would be glad to have their services utilised in the day-time; that the obstacle to physical training is the eagerness with which result fees are looked after, so that the teachers cannot spare the school children during the day. Surely the remedy for this is to include gymnastics in the school course, and to grant fees for successful physical as well as mental training, say in accordance with the school average width of chest. Mr. Alexander says, "Let there be a central training school, whose certificates will be granted to those who pass an examination of proficiency; let there be a code of exercises decided upon of a light, recreative, and popular character, with plenty of mental stimulus about them, as there should be about all exercises; let the exercises be useful, such as swimming drill, by which children can be thoroughly practised in the movements before they enter the water, thus facilitating their swimming lesson. If the Education Department will not give the necessary half-hour per diem for this, then at least give it directly after school hours, and watch the beneficial result that will surely take place. One or two professional instructors could visit the schools in each town, in order to keep up the standard of efficiency, and inspections could take place at convenient periods. *The experiment to have a fair chance should share in the result fees.*"

To show that it would be an easy matter to calculate the result fees to be given for average increase in circumference of chest in consequence of gymnastic training, I annex a form

prepared by Dr. W. P. Brookes, of Much Wenlock, who for many years has taken a deep interest in the question of physical training, and by which it will be seen that from statistics taken in the Much Wenlock National School for six months from August 21st, 1871, to February 21st, 1872, in the case of six boys who went through a course of drill and gymnastic training, consisting of the use of Indian clubs, the vaulting horse, horizontal and parallel bars, the average increase in chest circumference was $1\frac{5}{6}$ inches, or nearly 2 inches; whilst in the case of six other boys who went through a course of instruction in drill alone, it was but $\frac{11}{24}$ inches, or not quite $\frac{1}{2}$ an inch. I shall produce one more witness to the necessity for physical training, namely, Dr. George Fletcher, who has had large experience as a medical officer. In a paper on the "Management of Athletics in Public Schools," read before the medical officers of schools in January last, Dr. Fletcher insists that a large amount of exercise in pure air is required to keep lads in bodily health; and he contends that all games and physical exercises in schools should be regulated and under supervision. The experience I have gained as Chairman of the Metropolitan Public Garden Association has shown me the wisdom of this remark. Ordinary town lads are unacquainted with the games in which English school-boys of a higher social grade delight. Their ways are rough, they are unaccustomed to discipline; and if turned loose into a playground without supervision, are unable to avail themselves of the advantages offered there. Their sport degenerates into bullying or horse play, with no good physical result. Gymnastic apparatus under these circumstances becomes a positive danger, and broken heads, arms, and legs are certain to be the result if the lads are allowed to use them without supervision or instruction; but under a good teacher they soon learn discipline, enjoy themselves, and become as keen followers of organised games as any school-boy at Eton or Harrow. Dr. Fletcher's words are: "It should be remembered that, as regards compulsion in games, bodily exercise should be as carefully supervised by the masters as mental exercise; for it is not wise that boys should be left to manage these physical matters entirely by themselves, thinking that you can trust Nature and all will come right, and that the boy for whom exercise is desirable will be prompted by Nature to take just the amount required for his health. No such thing. In the general routine of lessons, a boy is compelled to conform to certain rules for the education of his mind; this is not here left to Nature nor to the boy's disposition, for if it were, there would, in most instances, be a miserable deficiency of brain exercises, or, in a few rare cases, a mischievous excess. If a boy does not like his Virgil or his Euclid, his masters do not leave him to take what he likes of these subjects. He is compelled to enter into them, and to get through a certain amount, and often will soon excel in some branch of study from judicious compulsion. So with games, do not allow the boy to play only when he chooses; at any rate, you are improving his bodily vigour, and he has had every chance of excelling in some branch of athletics. Let it fairly be instilled into the minds of parents by masters, that the education of the *body* is not far behind the education of the *mind* in importance, and the *amount* and *kind* of exercise both of mind and body should be always considered together."

Englishmen as a rule do not look to the Government to introduce reforms unless these reforms are first demanded by a large section of the community. This characteristic of the national temperament has its strong and also its weak side. If on the one hand it makes the people self-reliant, on the other it is a distinct discouragement to the spirit of amendment in governing bodies, who, instead of being continually on the alert to discover and put into practice improvements in the management of their different departments, as a rule consider it rather the duty of an official to throw cold water on all suggested innovations which threaten to alter the orthodox routine of work. The result of this customary apathy on the part of our officials makes it necessary for reformers to acquire popular support before bringing the question of any reform to the notice of governing bodies, and in order to obtain this support, the public must be educated and urged to action, by the subject requiring reform being constantly presented to their attention. Bearing these facts in mind, those of us who believe that in order to preserve the national health and physique at the proper standard, reforms in our system of education and in the management of our towns, are imperatively demanded, should not be disheartened because so little apparent progress would appear to be made in the popularisation of the national hygiene and of physical training, but should lose no opportunity of promulgating their views on the platform, through the press, and by all those means of spreading information which modern civilization affords. Action has already been taken in this direction by the Manchester Open Spaces Committee, and by the Metropolitan Public Gardens Association. The former has obtained the signatures of many influential and eminent men, including the names of H.R.H. the Duke of Cambridge, and General Lord Wolseley, to a petition urging the appointment of a Royal Commission to consider the question of physical training, and the latter body has sent the following memorial on the subject

to the Education Commission, and a somewhat similar one to the London School Board:—

To the Right Hon. Sir Richard Assheton Cross, M.P., G.C.B. (Chairman), and the Members of the Royal Commission on Education.

The Memorial of the Members of the Metropolitan Public Gardens Association,

Respectfully sheweth—

That your memorialists are of opinion that increased facilities for the physical training of the young of both sexes, and further provision for their wholesome recreation are much needed in all the larger towns of the United Kingdom, and feeling that this is a subject which is within the lawful scope of the enquiry of the Royal Commission on Education, they humbly beg to urge its consideration.

They base their belief upon the following grounds:—

1. That physical training is not at present one of the obligatory subjects for the ensurance of a Government grant in elementary schools.
2. That several teachers in Board or Voluntary schools are unable to give instruction in gymnastics or calisthenics either in the playgrounds or rooms of the schools.
3. That there is a want of some fund from which the maintenance, out of school hours, of existing playgrounds can be defrayed.
4. That there is great difficulty in obtaining, in densely populated districts, adequate open spaces for public recreation.
5. That there is a marked difference in bodily health and vigour, and in a pre-disposition to disease and immorality, between the young in the country and those in towns.

They believe that these difficulties might be overcome in the following ways:—

1. By the alteration of the Code of Education, so that physical training should be included among the obligatory subjects, and in this way necessarily introduced into each department of every elementary school.
2. By assistance given towards the introduction of instruction in physical training into the curriculum of all training colleges.

3. By the enforcement of a regulation that all playgrounds in connection with public elementary schools should be kept open, *under supervision*, for the use of the children and young people of the neighbourhood between and after school hours.
4. By the grant of further powers to local public bodies for the purchase of land for open or covered gymnasia, and for suitable recreation grounds for the use of the general public.

They believe that if these suggestions were carried out the following results would ensue to the rising generation:

1. A decrease in juvenile mortality, a better physical development, and a greater amount of bodily health.
2. An increase in the mental powers.
3. A decrease in crime, drunkenness, and immorality.

It is therefore the earnest desire of your memorialists that the members of the Royal Commission on Education should take this matter into their serious consideration, and consent to hear evidence upon the need of better means for physical training and increased facilities for wholesome recreation in all towns.

And your memorialists will ever pray, &c.

A National Physical Recreation Society has lately been established for the promotion of the physical education of the working classes, under the presidency of Mr. Herbert Gladstone, M.P., supported by the Hon. A. F. Kinnaird, Colonel G. M. Onslow (Inspector of Military Gymnasia), Lord Charles Beresford, M.P., The Hon. T. H. W. Pelham, and Mr. T. C. Edwardes-Moss, M.P., of athletic fame, with Mr. A. Alexander, F.R.G.S., Director of the Liverpool Gymnasium, as Honorary Secretary. An association with such influential leaders should be able to work wonders in the improvement of the physical education of the people; and in the confident hope that at no distant period the bodies of the poorer children of this country will be as well cared for as their brains, I ask those who hear me to-day to assist in forming a public opinion favorable to the maintenance by Municipal Authorities of open spaces, playgrounds, and gymnasia in towns, and to such alterations in the Education Code as will bring up a generation of English men and women, physically capable of bearing the burden of the high civilisation and extended Empire they have inherited from their forefathers.

APPENDIX.

Statistics of the Drill and Gymnastic Training given to twelve boys in the Much Wenlock National School, from August 21st, 1871, to February 21st, 1872.

Drill and Gymnastics.

Increase after Six Months in the Circumference			
Boy.	Of Chest.	Of Upper Arm.	Of Fore-Arm.
	Inches. Inches.		
1	From $27\frac{1}{2}$ to $28\frac{3}{4}=1\frac{1}{4}$ in.	$\frac{1}{4}$ inch.	Nil.
2	„ 28 „ $29\frac{3}{4}=1\frac{3}{4}$ „	$\frac{1}{2}$ „	$\frac{1}{4}$ inch.
3	„ 30 „ $31\frac{3}{4}=1\frac{3}{4}$ „	$\frac{1}{2}$ „	Nil.
4	„ $27\frac{1}{2}$ „ 29 $=1\frac{1}{2}$ „	$\frac{1}{2}$ „	Nil.
5	„ $28\frac{1}{4}$ „ $30\frac{1}{4}=2$ „	$\frac{1}{2}$ „	Nil.
6	„ $27\frac{1}{2}$ „ $30\frac{1}{4}=2\frac{3}{4}$ „	$\frac{3}{4}$ „	$\frac{1}{2}$ inch.

Average increase in circumference of chest $1\frac{5}{6}$ inches, or nearly 2 inches.

Exercises: Indian clubs, vaulting horse, horizontal and parallel bars.

Drill Alone.

Increase after Six Months in the Circumference			
Boy.	Of Chest.	Of Upper Arm.	Of Fore-Arm.
	Inches. Inches.		
7	From $24\frac{1}{2}$ to $24\frac{3}{4}=\frac{1}{4}$ in.	$\frac{1}{4}$ inch.	Nil.
8	„ $27\frac{1}{4}$ „ $27\frac{3}{4}=\frac{1}{2}$ „	$\frac{3}{4}$ „	$\frac{1}{2}$ inch.
9	„ $29\frac{1}{2}$ „ 30 $=\frac{1}{2}$ „	$\frac{1}{4}$ „	$\frac{1}{4}$ „
10	„ $26\frac{1}{4}$ „ $26\frac{3}{4}=\frac{1}{2}$ „	$\frac{1}{4}$ „	Nil.
11	„ $25\frac{1}{2}$ „ 26 $=\frac{1}{2}$ „	$\frac{1}{4}$ „	$\frac{1}{4}$ inch.
12	„ $25\frac{1}{4}$ „ $25\frac{3}{4}=\frac{1}{2}$ „	$\frac{1}{4}$ „	Nil.

Average increase in circumference of chest, $\frac{11}{24}$ inches, or nearly $\frac{1}{2}$ inch.

(Signed) W. P. Brookes, *Trustee.*
Edward Stroud, *Schoolmaster.*

Mr. S. W. North (York) said if persons lived in too close proximity to each other, their health was sure to suffer, therefore the question of open spaces resolved itself into one of the elementary principles of public health. No community could possibly do its duty if it did not take in the construction of towns. Streets should be of reasonable width, and public bodies did a great injustice when they allowed streets with "dead" ends, thus preventing a proper circulation of air. He also spoke in favour of gymnastic exercises as a means of aiding to promote health, and referred to the benefit which men who joined the army received from drill and the work in the gymnasium.

Surgeon-Major Black (Edinburgh) corroborated the statement of the last speaker as to the beneficial results of drill and gymnastic exercises in the open air upon the health of the soldiers, stating that such exercises and drill had been proved to have stopped the seeds of consumption from germinating fully.

Surgeon-Major Pringle (London) gave his testimony in the same direction, and said that Lord Brabazon had done a noble work in converting practically useless places in towns into recreation grounds, which acted as lungs to the poor.

Mr. C. Roberts (London) thought that girls needed gymnastic exercises as well as boys, and thought there was a danger when these exercises were pushed too far, especially when they assumed the form of military drill. He supported Lord Brabazon's view that open spaces in towns were most valuable.

Ald. Rowntree (York) thought it would be interesting if someone would state what had been the practical means adopted in the localities where Corporations had taken over the charge of burial grounds and open spaces, for securing their proper oversight. The Corporation of York were the owners of the moats and grounds round the walls, and there had been a considerable desire among the people to have them opened for the use of the children. What had stood in the way was the inability to find a practical way for keeping these places under proper oversight. There was in this city a very interesting illustration of the care taken of open spaces by local bodies in the past. It was related that a great struggle took place between Queen Elizabeth and the Corporation in regard to the keeping open of St. George's Field, near Skeldergate Bridge, in which the Corporation were, happily, successful, and the Queen surrendered her claim. The citizens of York, therefore, had reason to be thankful for the pertinacity of their ancestors in the Corporation.

Mr. G. J. Symons, F.R.S. (London), expressed the pleasure with which he had heard Mr. North's views against streets with "dead ends," as the *cul-de-sac* was called. Such streets could not have what all streets needed, a "flushing" of air, and he trusted that Corporations would do all they could to abolish such places in future.

Dr. Ewart (Brighton) held that the cry for open spaces was only part of a "system," requiring fuller development for the sanitary and hygienic amelioration of the general conditions and surroundings of all classes of the community, and he suggested that other remedies were required besides open spaces to make healthful populations; particularly in the construction, ventilation, and sanitation of the so-called homes of our labourers and artizans.

The Chairman, Mr. W. Whitaker, gave his opinion from experience, that drill was most beneficial.

Alderman Rymer (York) asked for information respecting the care-taking of open spaces formed under Lord Brabazon's auspices.

Thanks were voted to Lord Brabazon.

"*On Medical Climatology: a Scheme for defining Local Climates by combined meteorological and phenological observation*," by Charles Roberts, F.R.C.S., &c.

We must not confound the study of climatology with that of meteorology. Meteorology is the science of the atmosphere in its purely physical aspects, but climatology is the science of the atmosphere in its physical, chemical, and biological aspects, and also of the physical, chemical, and biological aspects of the earth's surface in contact with it. Meteorology deals with the weight, temperature, aqueous vapour, movements, and electrical condition of the atmosphere—in one word, with the weather—but in addition to the weather, climatology deals with the quantity and quality of the air, the sunshine, and the soil. If to these numerous elements we add their influence on the human body in health and disease, we have the very comprehensive science of medical climatology.

There is a very decided difference in the methods of investigation of the meteorologist and the medical climatologist. The former deals principally with averages, the latter with extreme meteorological conditions. Living organisms have the power of accommodating themselves to a considerable range of variations in external conditions, and it is the limits of these ranges of variation which are of importance to the medical climatologist. Or to put the question in another form, living organisms vary with the physical conditions to which they are subjected; and hence different organisms declare and embody the different conditions to which they have been exposed, and this is true of geological as well as meteorological conditions.

Now, if we examine the whole range of living things we shall find that plants are most exposed to, and most distinctly declare the geological and climatic conditions of a country or district. Being fixed to the soil, they show its character; and being confined to one place they sum up the whole range of meteorological phenomena to which they are and have been exposed. The tolerance of different species of plants for different amounts of temperature, rainfall, sunshine, atmospheric impurities, &c., constitutes them veritable "weather glasses" of different degrees of sensibility, from which we can gather a more distinct idea of the climate of the place in which they survive than from any number or combination of meteorological instruments: hence the advantages of the phenological method of studying climate.

The idea is by no means new. Linnæus was fully aware of its utility, and set some of his most distinguished pupils to collect observations, not only on the geographical distribution of plants, but on the four most characteristic phases of plant life, viz., leafing, blossoming, fruiting, and the fall of the leaf, in individual plants. Several "Calendars of Flora" resulted from these early enquiries.

In 1844 Mr. Quetelet, the distinguished Belgian astronomer and meteorologist, put forth a large scheme for determining the periodic phenomena resulting from the change of the seasons and climatic causes, which was considered and revised to suit our British flora and climate by a committee of the British Association (consisting, among others, of Professors Owen, E. Forbes, Ball, Allman, Babington, Dr. Lankester, &c.), and was published in the Reports for 1845. The scheme was a very elaborate one, requiring observations on nearly 600 plants, animals, birds, and insects, which placed it beyond the range of most people's powers, either to identify the objects, or keep a record of the phenomena they displayed. The chief advantage of the scheme is the careful definitions of the most suitable objects for phenological observations, and the best methods of carrying out such observations.

For several years past a Committee of the Royal Meteorological Society has been collecting observations on a much shorter list of plants, birds and insects, confining its attention to the one phase of the blossoming of wild plants, and the first appearance of a few insects and the most regular of our migratory birds. The disadvantage of this scheme is that it embraces too many objects and too few phases of plant life, and covers little more than half the year, and it does not demand any concurrent meteorological observations.

Last year (1885) a short scheme was published by Dr. Hoffmann, of Giessen, based on the results of his own forty years' observation, and on the data collected from registers kept at about 2000 stations in various parts of Europe, including 200 in the British Isles. This scheme comprised a few common trees and shrubs which require no botanical skill to identify, and embraces all the four phases of plant life recommended to be noted by Linnæus and Quetelet. Its defect, as that of all other schemes previously propounded, is in the absence of recognition of the importance of corresponding meteorological observations which would show the relative climatic value of the phenological records.

Last year I received from the Rev. T. A. Preston, of Marlborough, a series of observations made on the blossoming of plants, the migration of birds, and the appearance of a vast number of insects, and with them a series of meteorological tables covering the same period of time (the 20 years from 1864 to 1884). By working out the averages of both sets of observations, and arranging them side by side for every day of the year, I have shown—as far as averages can be trusted—the temperature and moisture equivalents of the blossoming of each plant, and the appearance of each insect. This has been done by working out the accumulated temperatures above 42° (the assumed zero of vegetation by botanists) by the rules laid down by the Royal Meteorological Society; and the accumulated rainfall, by distributing the monthly rainfall equally over every day of the month, and adding it up for every day of the year in succession from the 1st January. This is, I believe, the first attempt which has been made to correlate meteorological and phenological observations.*

It would not be a difficult task to construct short lists of plants, &c., to represent the various meteorological elements separately, and with a prospect of obtaining results from them which would be of great value to medical climatology.

1. The different elevations of a country are distinguished by different species of plants and trees, but as our country does not possess decided variations of this kind it is unnecessary to give such a list here. The retardation of vegetation is sufficient for this purpose.

2. A list of plants, even within a single natural order, such as Ranunculaceæ (*i.e.*, Marsh Marigold to the Traveller's Joy), could be constructed to show the relative dampness or dryness

* For a full discussion of this subject see the introductionto my "Naturalist's Diary: a Day-book of Meteorology and Phenology." Sonnenschein & Co., London, 1886.

of the soil and atmosphere of two districts, but the rainfall and atmospheric humidity are best dealt with in conjunction with temperature.

3. The lowest range of temperature of a district is of great importance in connection with many diseases and the selection of suitable winter health resorts, and the simple survival of many sub-tropical plants in temperate regions is a valuable indication of the general climatic conditions. The following list has been drawn up from my own observations at various Mediterranean health resorts. The observations should relate to the (A) growing, (B) blossoming, and (C) ripening of fruit. Many of these plants will grow in other than their native situations but will not flower, while others will grow and blossom but will not ripen their fruit. These facts should be noted.

Adam's Needle (*Yucca gloriosa*), A, B, C.
Almond (*Amygdalus communis*), A, B, C.
Aloe, American (*Agave Americana*), A, B.
Bamboo (*Bombusa vulgaris*), A.
Banana (*Musa sapientum*), A, B, C.
Camellia (*C. japonica*), A, B.
Fig-tree (*Ficus carica*), A, B, C.
Gum-tree (*Eucalyptus globulus*), A, B.
Juniper (*Juniperis communis*), A, B, C.
Lemon (*Citrus Limonum*), A, B, C.
Magnolia (*M. grandiflora*), A, B.
Maize, A, B, C.
Myrtle (*Myrtus communis*), A, B.
Oleander (*Narium oleander*), A, B.
Olive (*Olea Europæa*), A, B, C.
Opuntia (*O. ficus-indica*), A, B, C.
Orange, sweet (*Citrus aurantium*), A, B, C.
Palm, dwarf, European (*Chamærops humilis*), A.
Pomegranate (*Punica granatum*), A, B, C.
Vine (*Vitis vinifera*), A, B, C.

4. We possess no ready means of testing the relative purity of the air. The ozone tests fail us at the very outskirts of towns and manufacturing districts, and chemical analysis is difficult and not always satisfactory. Here the growth of plants is of great value, as different species possess different degrees of sensibility to atmospheric impurities of both a chemical and mechanical description. The diagram on page 273 shows the relative viability of a few common trees, shrubs, and flowers in London and its neighbourhood, the result of my own four years' observation.* Each square represents an area in which the plants included in it will grow, but in which the plants represented in the next square would not survive. The scheme comprises four different groups of plants: deciduous trees, evergreens, coniferous trees, and common garden or window flowers. It is not necessary that observation should be made on all of them, and preference, if any, should be given to deciduous trees. The scheme will be applicable to large manufacturing areas as well as to large towns.

* For a similar set of observations see R. Garner, Rep. Brit. Assoc., 1863.

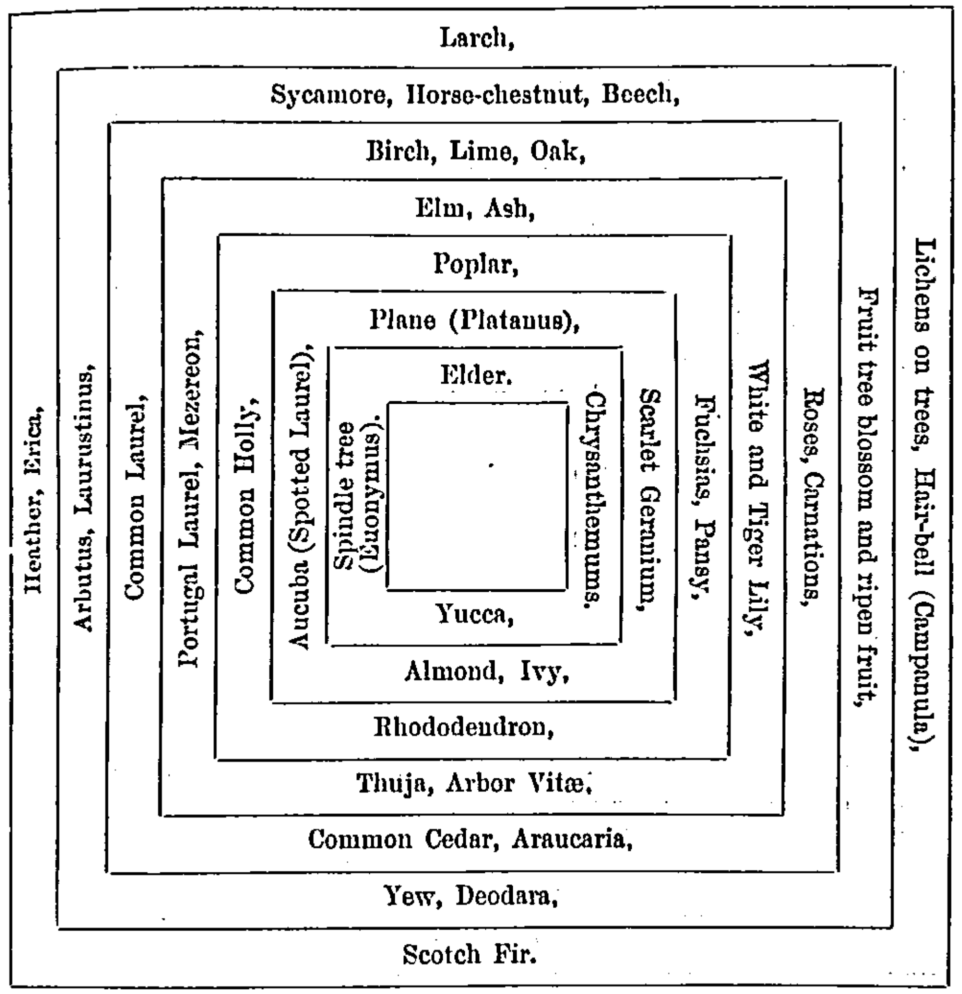

Diagram showing the sensitiveness of different species of trees and plants to chemical and mechanical (soot, &c.) impurities of the atmosphere of towns and manufacturing districts.

5. Prevailing winds are indicated by the inclination of trees, especially of rapid growing ones like the common poplar, and by the greater freedom from moss and lichens on the weather aspect of exposed trees, especially of the pine family. Near towns, soot on the stems of trees indicates the direction of prevailing winds. Round the coast, and especially on the eastern side of England, trees lean inland from the injury done by sea breezes; but inland the south-west aspect of trees suffers most from winds. This is a subject which is deserving of more attention than it has yet received.

6. The presence or absence of sunshine is indicated by the relative prevalence of leaves and flowers. But this question is largely dependent on rainfall, as a large rainfall not only produces an excess of leaves, but, being accompanied by clouds,

the sun becomes obscured by them. Sunshine is also related to temperature, and as a low temperature is shown by the postponement of the blossoming of flowers, and especially by the deficient ripening of fruits, the quantity and quality of the sunshine is indicated by ordinary phenological observations.

The schedule on page 275 has been constructed from the trees and plants included in Dr. Hoffmann's scheme. A few plants have been omitted as they are little known in this country, and I have added the almond as the best representative we possess of the early blossoming wall-fruit trees.

By making simultaneous observations in various parts of the country and recording them on this schedule, it will be possible to lay down on a map several *isophenal* lines similar to, but by no means identical with, the isothermal lines laid down by meteorologists, and thus show at a glance the stations which possess corresponding climates, and the amount of difference between others.*

Mr. G. J. Symons, F.R.S. (London), referred to the paper as being one in connection with a greater work which Dr. Roberts was doing, and said that in these labours he was perpetuating a work commenced long before his time by Gilbert White, of Selborne. The speaker then reviewed the progress which had been made in the subject before them by Dr. Roberts, and by various savants in Germany and France, referring particularly to the works of eminent writers in those countries, and dealing with the action of the German and French governments with regard to meteorological observations. He entered into the details of the formation of maps by eminent meteorologists and climatologists, and with respect to the observations made on the blossoming of plants stated that, as regarded the education of youth, and the enlistment of the future generation, a good work was being carried on at Marlborough College, where the pupils had formed a museum of the plants obtained at different elevations, and Mr. Preston, who had been referred to in the paper, had made observations upon the collections thus formed. The speaker then dwelt upon subjects of accumulated temperatures and of rainfalls presented in the tables, and stated his own impressions upon the various *data* thus given.

Mr. Clark (York) said that observations made upon 31 flowers at 15 to 20 stations, largely by scholars at various schools, had now

* For some beautiful maps of this kind see *Etude sur la Marche des Phénomènes de la Végétation en France*, by M. A. Angot. Bureau Cent. Mét. de France. Annales 1882.

SCHEDULE FOR DETERMINING LOCAL CLIMATES BY PHENOLOGICAL OBSERVATION.

N.B.—The observations included in the list were made at Marlborough, long: 1° 43′, lat. 51° 25′, elevation above sea, 400–500 feet. Soil; downs, arable, and forest, on chalk. 50 miles from the sea.

Note.—In addition to observing the phases of vegetation of the following trees and plants, it is desirable that observation should be made on the max. and min. temperature in the shade, from which the mean temp. and the accumulated temperatures can be calculated. The rainfall, and number of rainy days should be recorded. The elevation above the sea, lat. & long. must be stated.		Habitat. The trees and plants should be growing under natural conditions, and not sheltered by houses, walls, or other trees. The same trees should be observed from year to year. Note soil & subsoil.	Date of blossoming at Marlborough, average of 20yrs,1864-84. Doubtful obs. in England.	The figures represent the temperature and moisture equivalents of the blossoming of each plant. Accum. Temp.	Accum. Rainfall.	Blossoming. First blossoms open at various places.	Leafing. First leaf-surface visible.	Fruiting. First fruit ripe, seeds brown.	Leaves changing. Half the leaves changed in colour.	Leaves falling. Half the leaves fallen.	Remarks.
Hazel-nut Tree	Corylus Avellana (Catkin)	Hedge-rows	I 31	58·4	3·56						
Almond	Amygdalus communis	Shrubberies	III 17 ?	181·5	7·46						
Blackthorn, or Sloe	Prunus spinosa	Hedges, Commons	IV 1	236·7	8·46						
Pear, common choke	Pyrus communis	Orchards only	IV 2 ?	242·1	8·53						
Red Currant	Ribes rubrum	Open Gardens	IV 9	286·4	9·07						
Wild Cherry, or Gean	Prunus avium	Woods, open spaces	IV 18	350·5	9·75						
Birch Tree	Betula alba (Catkin)	" " "	IV 21 ?	374·1	9·98						
Broom	Sorothamnus (Spartium) Scoparium	Commons	IV 30	449·0	10·66						
Crab-apple	Pyrus Malus	Hedge-rows	V 5	487·8	11·00						
Lilac	Syringa vulgaris	Shrubberies	V 5								
Horse-chestnut	Æsculus Hippecastanum	Parks, single trees	V 6	497·8	11·07						
Oak	Quercus Rober (Catkin)	" " "	V 13	563·9	11·56						
Hawthorn, "May"	Cratægus Oxyacantha	Hedge-rows	V 13								
Laburnum	Cytisus Laburnum	Shrubberies	V 14	574·2	11·62						
Mountain Ash, Rowan	Pyrus (Sorbus) aucuparia	Shrubberies, Commons	V 14								
Rye, winter	Secale cereale hibernum	Cultivated	V 15	584·3	11·68						
Deadly Nightshade	Atropa Belladonna	Hedge-rows	V 19	626·7	11·96						
Elder	Sambucus nigra	"	V 27	722·0	12·50						
Raspberry	Rubus idæus	Open Gardens, Commons	VI 1	784·8	12·85						
Snowberry	Symphoricarpos racemosa	Shrubberies	VI 2 ?	798·5	12·94						
Dogwood, or Cornel	Cornus sanguinea	Hedge-rows	VI 11	919·4	13·67						
Privet	Ligustrum vulgare	Shrubberies, Hedges	VI 20	1054·0	14·14						
White Garden Lily	Lilium candidum	Shrubbery Garden	VII 5 ?	1306·5	15·70						
Lime Tree	Tilia europæa	Parks, open spaces	VII 9	1375·4	16·07						

for ten years been tabulated in the *Natural History Journal*. The observation asked for was that of the first flower showing stamens.

Surgeon-Major BLACK (Edinburgh) expressed his doubts as to whether there was any connection between the deterioration of plant life and the condition of human health. He declared his opinion that an atmosphere which would not grow vegetation was not inimical to health, and pointed out that in some parts of Lancashire, which grew very good men, the atmosphere was so poisoned by the emanations from factories that trees would not grow.

Surgeon-Major PRINGLE (London) considered that the climate was often indicated by the changes in the character of the vegetation, and detailed, from his experience in India, the difference in the character of the same plants in different altitudes in the Himalayas, stating that while some plants under certain conditions flourished, under others they were dwarfed, and in some, while the roots lived above ground the plant appeared scarcely to be alive.

Dr. CHARLES ROBERTS (London) made a short reply, in the course of which he stated that he was still continuing in his observations.

Thanks were voted to the reader.

On "The Filtration of Water for Town Supply," by PERCY F. FRANKLAND, Ph.D., B.Sc.Lond., F.C.S., F.I.C., Associate of the Royal School of Mines.

THE filtration of water on the large scale which has now been carried out in London and other places for so many years past, has resulted in much valuable experience being collected by the engineers to whom this process has been entrusted. In this work of improving the methods of filtration, engineers have, however, been but little assisted by science, and have been guided almost entirely by empiricism. It is true that from time to time the subject of filtration has been investigated by chemists with a view of ascertaining the value of this process in removing the organic matters present in water, but these enquiries have resulted in little of practical value beyond demonstrating that in the process of sand-filtration it is only new sand which effects

any noticeable reduction in the dissolved organic matter present. Engineers have, however, not modified their practice in consequence of this information, inasmuch as they are aware that old sand as well as new will produce water clear to the eye, and the removal of at best a small proportion of organic matter has not, in their opinion, justified the additional expense which a frequent renewal of sand would entail.

Briefly, therefore, the object of the water engineer has been to obtain for each acre of filter-bed as large a volume of water which is clear to the eye, regarding the organic matter in the water as a factor which is beyond his control, and which can only be modified by changing the source of supply.

Sand-filtration has, therefore, not unnaturally been held in little repute by chemists, who fail to recognize, as of any sanitary importance, a process which has no material influence upon the dissolved organic impurities of water.

For many years past we have, of course, been fully alive to the fact that the real danger in sewage contaminated water, does not reside in the organic matter discoverable by chemical analysis, but in the presence of minute living organisms capable of producing zymotic disease. But until the last five years very little was known either of these organisms themselves or of the manner in which they would deport themselves under the various processes of purification to which water is subjected. It is to the beautiful methods of bacteriological investigation, which we largely owe to the genius of Robert Koch, that is due the great advance which has recently been made in our knowledge of the sanitary conditions of water-supply, and more especially of water purification. Indeed it is difficult to overestimate the stimulus which has been given to this important branch of science, by the introduction of these novel methods of investigation.

By the light of researches on the bacteriology of water made with the assistance of these methods, the process of filtration assumes an altogether new aspect, as its efficiency can now be gauged by another standard besides the naked eye of the engineer or the organic analysis of the chemist. A standard, moreover, which is far more closely connected than are either of the others with the sanitary aspects of the question.

By means of the methods of Koch, which I have described elsewhere,* it is possible to determine, with very considerable quantitative accuracy, the number of micro-organisms in a given volume of water, so that, by submitting the water-supply of a town to this examination before and after filtration, or,

* Proceedings, Royal Society, 1885. Journal, Society of Chemical Industry, 1885.

indeed, before and after any other form of purification, we ascertain whether and to what extent the filtration or other process of purification in question has been effective in removing the micro-organisms from the water.

Now, although the organisms thus removed are probably in general perfectly harmless, it must not be supposed that their removal is of no importance, for it must be remembered that the micro-organisms which are known to produce disease, and which are termed "*pathogenic*," do not in any way differ from the ordinary organisms in water so as to render it probable that they would behave differently in the process of filtration; but, on the contrary, there cannot be any serious doubt that their behaviour under these circumstances would be precisely similar. Now, such disease-organisms frequently do gain access to water, and it is obviously of the greatest importance to ascertain what sort of impediment this process of filtration, which is so largely practised, offers to their passing on to the consumer.

By means of this bacteriological examination, it is thus possible to obtain a far more satisfactory knowledge of the kind of filtration which water has undergone than by a mere appeal to the eye of the observer, and the vague terms "turbid," "slightly turbid," "clear," and the like, which have hitherto been employed to describe whether the filtration of water has been satisfactory or not, must now be replaced by this scientific and important standard which I have described.

The value of this standard has been duly recognised by Col. Sir Francis Bolton, the Official Examiner under the Metropolis Water Act, and for nearly two years past I have now periodically submitted the London Waters to this test, and during the past twelve months these results have been published by the Local Government Board.

These periodical examinations, on the one hand, of the river waters from which the water-supply of the Metropolis is mainly derived, and, on the other hand, of the water after filtration, as supplied to the consumer, have fully established the extraordinary power which this simple process of sand filtration possesses of removing micro-organisms from water. In the following Table I have recorded the averages of the reduction in the number of micro-organisms, obtained during the first six months of the present year, in the water drawn from the rivers Thames and Lea respectively:—

Reduction in the Number of Micro-organisms present in the River Waters supplied to London.

1886.	River Thames. Chelsea, W. Middlesex, Southwark, Gr. Junction, and Lambeth Co.'s.		River Lea. East London Company.
January	95·6 per cent.	....	99·4 per cent.
February	98·6 "	....	98·8 "
March	95·3 "	....	94·1 "
April..........	99·1 "	....	96·3 "
May	98·8 "	....	95·2 "
June	98·9 "	....	90·5 "
Average for 6 *Months*,	97·7 "	....	95·7 "

These figures give a definite picture of the efficiency of the treatment as regards the micro-organisms present in the waters.

In the following Table are recorded the figures from which the above averages are obtained, viz., the number of microbes found in one cubic centimetre of the unfiltered river waters, on the one hand, and, on the other hand, the number of microbes found in one cubic centimetre of the waters supplied by each of the Metropolitan Water Companies, drawing from these sources:—

Number of Micro-organisms contained in 1 *cubic centimetre of London Water.*—1886.

	Jan.	Feb.	March.	April.	May.	June.
Thames.						
Unfiltered Thames water at Hampton	45,400	15,800	11,415	12,250	4,800	8,300
Chelsea..	159	305	299	94	59	60
West Middlesex ..	180	80	175	47	19	145
Southwark	2,270	284	1,562	77	29	94
Grand Junction ..	4,894	208	379	115	51	17
Lambeth	2,587	265	287	209	136	129
Lea.						
Unfiltered Lea water from intake of East London Co.	39,300	20,600	9,025	7,300	2,950	4,700
New River	363	74	95	60	22	53
East London.. ..	224	252	533	269	143	445

A glance at this latter Table shows that there is a certain uniformity in the position which the various companies occupy as regards freedom from micro-organisms, and, as I shall presently show, there is an unmistakable relationship between this position of each company and certain factors in its mode of working, which theoretical considerations lead us to anticipate should affect the results.

The factors, which in my opinion, are more especially calculated to influence the number of microbes present in the distributed water are the following:—

1. Storage capacity for unfiltered water.
2. Thickness of fine sand used in filtration.
3. Rate of filtration.
4. Renewal of filter-beds.

1. *Influence of Storage Capacity for Unfiltered Water.*—Firstly through greater storage capacity, the necessity of drawing the worst water from the river is avoided, a matter which in the case of a stream like the Thames, liable to frequent floods, is of great importance. Again, during the period of storage, subsidence takes place, the water depositing the greater part of its suspended matter, along with which a large proportion of the micro-organisms will also go to the bottom. Then a further diminution takes place through degeneration and decay of the microbes, for as I have recently shown* the number of micro-organisms in the unfiltered river-waters diminishes on keeping irrespectively of subsidence, probably owing to the competition between different forms hostile to each other, as well as by the production of chemical compounds inimical to their further multiplication.

2. *Influence of Thickness of Fine Sand.*—That the thickness of the filtering stratum should exercise an important influence on the number of micro-organisms passing through the filter must be sufficiently obvious. In estimating the thickness of such a sand filter the fine sand only should be taken into consideration, as it is only this portion of the filter which can have any effect in the removal of microbes.

3. *Influence of Rate of Filtration.*—That the filtration is the more perfect the slower the rate, is sufficiently well known to all who have studied the subject of filtration either on the small or the large scale.

4. *Influence of Renewal of Filter-beds.*—In my experiments† on filtration in the laboratory I found that even the most perfect filtering media sooner or later lose their power of retaining microbes, and hence the importance of frequent renewal must be apparent.

* Proceedings, Royal Society, June, 1886.

† Water Purification, its Biological and Chemical Basis. Proceedings Inst. of Civil Engineers, April, 1886.

In considering how the differences in these various factors, which the statistics of the London Water companies exhibit, may be expected to influence the results obtained in the removal of micro-organisms, attention must be restricted to the five companies drawing water from the Thames, as it is only these which have practically the same raw material to deal with, for the amount of organic life in the river Lea at the intake of the East London Company is often very different from that in the Thames at Hampton, and the difference in the case of the intake of the New River Company is doubtless even still greater, besides the problem being there complicated by the admixture of a very considerable proportion of deep well water.

The close proximity of the intakes of the five Thames companies, however, furnishes a peculiarly favourable opportunity for instituting such a comparison.

The factors in the mode of working, which have been pointed out above as of special importance in exercising an influence upon the result obtained, are given in the following Table, the figures being taken from the statistical Table given in Sir F. Bolton's "London Water Supply," published in 1884 in connection with the Health Exhibition at South Kensington.

More Important Factors in Mode of Treatment by Thames Water Companies.

Name of Company.	Average Daily Supply in Millions of Gallons.	Available Storage Capacity in Millions of Gallons.	Average Storage in Days (Calculated).	Rate of Filtration per Square Foot in Gallons per Hour.	Thickness of Fine Sand.	Renewal of Filter-beds (calculated).
						Proportion of total acreage cleaned per Month.
Chelsea	9·5	140·0	14·7	1·75	4ft. 6in.	0·59
West Middlesex ..	12·8	117·5	9·2	1·5	3ft. 3in.	0·90
Southwark	19·9	66·0	3·3	1·5	3ft. 0in.	0·90
Grand Junction ..	14·1	64·5	4·6	1·75	2ft. 6in.	0·81
Lambeth	14·2	128·0	9·0	2·0	3ft. 0in.	0·50

By means of this Table the five Companies may now be classified with respect to each of the four factors in question, thus:—

COMPANY.	Storage Capacity.	Thickness of Fine Sand.	Rate of Filtration.	Renewal of Filter-beds.
Chelsea	1	1	3	4
West Middlesex	2	2	1	1
Southwark	5	3	1	1
Grand Junction	4	5	3	3
Lambeth	3	3	5	5

From this the general order of merit, as regards these factors, can be deduced, by taking the average position of each Company, thus:—

COMPANY.	Average Position.		Order of Merit.
Chelsea	2·25	....	2
West Middlesex	1·5	....	1
Southwark	2·5	....	3
Grand Junction	3·75	....	4
Lambeth	4·0	....	5

From the theoretical considerations here instituted, it would be anticipated, therefore, that dealing with the same raw material the West Middlesex Company should, on the whole, obtain the best average as regards the removal of micro-organisms, and that the results obtained by the other four companies would follow in the order of Chelsea, Southwark Grand Junction, and Lambeth.

In the following Table the actual position, as regards freedom from micro-organisms, of each company is recorded for each of the first six months of the present year:—

COMPANY.	Chelsea.	West Middlesex.	Southwark.	Grand Junction.	Lambeth.
1886.					
January	1	2	3	5	4
February	5	1	4	2	3
March	3	1	5	4	2
April	3	1	2	4	5
May	4	1	2	3	5
June	2	5	3	1	4
Average..........	3	1·8	3·2	3·2	3·8

Arranging the companies according to these averages, the following series is obtained.

West Middlesex	1
Chelsea	2
Southwark........................} Grand Junction ....}	3
Lambeth	5

This series it will be seen is all but identical with that which was indicated above by theoretical considerations.

This remarkably close coincidence between theory and practice clearly shows that filtration is no longer a process which should be guided by empirical rules, but that this most important function of filtration—the removal of micro-organisms —is dependent upon principles with which we are already intimately acquainted, and which are largely under our control.

When it is remembered that the results of filtration quoted above have been obtained by engineers working quite independently of any theoretical considerations of the kind to which I have here referred, we may surely look forward with confidence to even still more successful and uniform results when practice is assisted by this novel departure of sanitary science.

Some few observations were made by Dr. Hill (Birmingham), Dr. Tempest Anderson (York), and by M. Platnauer (York), with respect to microbes being found in filtered water.

Mr. Rymer (York) asked some questions in relation to filtration substances. He pointed out the differences between some of the sands, and dealt generally with the question of the filtration of the water supplied to the inhabitants of York, where river sand is very largely used.

Mr. Clark also spoke on the same question.

Professor Hope (York) asked those who visited the water-works to take particular notice of the excellent contrivances which were there utilized for washing and purifying the filtering sands.

Mr. W. Whitaker (The Chairman) said that the great interest in this paper had been displayed by the various questions asked of Dr. Frankland. His opinion was that for the purpose of filtration it was necessary to have as clean, even-grained sand as it was possible to obtain.

Dr. Percy Frankland (London), in referring to the subject of the organisms in water, remarked that he had found that very rapid multiplication of the microbes took place in the storage of filtered water; the increase proceeding up to a certain point, after which the number again diminished. In deep well water he had found this multiplication to be even still more rapid and pronounced, whilst in unfiltered river water he had not observed any such multiplication on storage, but, on the contrary, a continuous decrease. He believed these differences to be due to the fact that in the unfiltered river water there were a number of different varieties of organisms, many of which were probably hostile to each other. In the filtered river water the number of different varieties besides the absolute number of organisms was very much smaller, and hence the struggle for existence was less intense, and multiplication could proceed until an equilibrium between the different individuals was reached, whilst in the deep well water the number of organisms, as well as the number of different varieties, was even still smaller, and hence the struggle for existence was less severe even than in the filtered river water, and consequently the multiplication of the few organisms present still more rapid. Experiments which he had made on the duration of life of pathogenic organisms in water, had shown that although some varieties, such as the "comma bacilli" of cholera, could be preserved in water for a number of days, no multiplication took place, but on the contrary, a more or less rapid diminution in their number was observed. In sewage, however, he had found they flourished and multiplied abundantly.

On "*The Sanitary Condition of the Country, with special reference to Water-channels*," *by* ROBERT T. COOPER, M.A., M.D.

SOME explanation is needed as to the title we have chosen for this paper. Coming before an assembly like the present, at whose meeting almost every question bearing upon the health of the community has from time to time been discussed, it may seem absurd to affirm that the sanitary condition of the country generally is such as ought to arouse to activity the people of this and of every land.

The neglected condition of the channels in which the rainfall of the country should be stored, and through which it should discharge, is intimately connected with the health and well-being of the community, and this, I venture to assert, constitutes a fitting theme of discussion for a Sanitary Congress.

Sanitary authorities have in late years expended much time upon, and given much thought to, the consideration of the best methods to be adopted for effecting the removal of refuse material from dwelling houses and towns.

They have also discussed at some length the ever recurring and increasingly important question, among all manufacturing communities, of the pollution of rivers.

My object in coming forward is not of course to refer to the condition of dwelling houses and cities, nor even to discuss the subject of river pollution as this is generally understood, but rather to insist upon the necessity, urgent and imperative as it is, of directing the attention of the members present, and through them of our parliamentary representatives, to the generally defective condition, and not merely the pollution, of the streams and rivers of the country.

In a lecture I delivered at the Balloon Society, on Friday evening, 16th July, 1886, on *Our Empire of Rivers*, I entered somewhat largely into this subject. But my intention now is to direct attention to the great importance of our rivers as channels for the storage of pure and unpolluted water, and the necessity, from a hygienic point of view, of adopting measures to secure a sufficient, gentle and continuous flow of water through them.

This is a question of grave importance not alone to England; it demands, very urgently, the consideration of the inhabitants of every part of the civilized world.

Gradually but certainly populations increase; and, impelled as well by ambition as by necessity, men are at the present day driven to select a city rather than a country life.

The consequences of this to the country are that it is neglected, and less money is being expended upon it, and less consideration paid to its sanitary and agricultural condition than would otherwise be the case.

Sanitary science, represented as it is by this august assembly, has done a great deal towards rendering city life more healthy, and in every way more endurable; the time has now come when the attention of the entire community must be directed to the sanitation of the country districts. This is a matter that involves the life and death of individuals, the existence of our cities, the continuance and progressiveness of our race, and the welfare of all mankind. The resident population of England, Scotland and Wales, has increased from about 11,000,000 in the beginning of the century, to about 35,000,000 at the present moment. One necessary and obvious result of this is that a much larger amount of material has been loosened from its surroundings and sent adrift, and this has proportionately added to the silt in our rivers.

This being the case, it is evident that it is more than ever incumbent upon us to adopt measures that are calculated to keep these channels freely flowing and their contents in a natural and pure condition.

It is a fact beyond dispute that our rivers, and the tributaries and sub-tributaries of our rivers, are silting up very rapidly; and indeed the only possible inference is that accumulations are being thrown down in a proportionately greater quantity than when we had a less population.

If then this be the case—and a mere "walk over" our fields will convince the most sceptical, by the very tangible evidence of the beds of dried-up streams, of the urgency of the situation, and, inferentially, of the danger that exists to the health, well-being, and safety of the community, the situation is the gravest—it admits of no delay.

The agricultural poverty of this country will most assuredly and most unmistakably intensify the present disastrous condition of our streams; it will be followed by the most calamitous consequences, if Government refuses to take in hand the supervision of the water-ways, and the proper foresting of the country.

Our imperative duty is to warn the Government and people of England of the fatal results which inevitably ensue from a continued neglect of water-channels, and of the need there is of an immediate outlay of national funds in the interests of the land and of the people of the country.

It cannot be too often or too perseveringly impressed upon the notice of the public, that if the smaller streams throughout the country are allowed to silt up and become inoperative during times of drought, the effect will be the desiccation of the soil and consequent loss of fertility, and the lessening or even complete exhaustion of the water coursing through the rivers themselves.

Such absence of thought is displayed upon this subject, that a person to whom I communicated this neglected state of our rivers, very innocently observed how desirable it was to take measures to secure the efficiency of our larger water courses, and leave alone the smaller ones, so as to have the cities well supplied with water. It did not seem to occur to my friend, as it does not to many, that it is impossible to have large rivers unless we possess and pay attention to the succession of small streams by which these should be perennially supplied.

The tendency of all badly supervised water channels, especially of those that course through soft argillaceous and arenaceous strata, in countries and portions of country having no protection for their uplands, is to silt up. And the beds of rivers and streams being in this way raised, their efficiency for the purpose of natural water storage is dangerously diminished.

Hence it comes that not alone do our rivers fail to afford adequate moisture to the adjacent fields in the dry seasons, but when rain falls the country becomes flooded, and loss of life and destruction of property result. So that in fact that which ought to bring prosperity to the agriculturist, and increased and sustained fertility to the soil, is attended with destructive and injurious results, owing to the insufficient capacity of the water storage channels of the country.

And then the land becoming water-logged, inferior vegetation springs up, and owing to this too extensive evaporization fogs prevail; and the heat of the sun, expended upon the vaporization of the extended, watered areas, is thus hindered from exerting its full influence upon the soil. This, as we know, is one of the most fruitful causes of malaria, and the prevalence of fog leads to the deterioration of the vital activity, both of the cattle grazing upon the fields and of the inhabitants of the adjoining districts.

And besides all this, a country thus uncared for furnishes a fungus-growing surface, upon which the germs of infective diseases increase and multiply. Hence it is evident that the creation and preservation of a perennial supply to the water channels of the country is necessary to the maintenance of the healthy activity of human life, and indeed of all forms of animal and vegetable existence.

This being the case, it behoves us to consider very earnestly what steps ought to be taken to effect a consummation so devoutly to be wished as the restoration and conservancy of the natural storage channels of the country, and the strict protection of their catchment areas.

In the first place it will be necessary to seek, nay to demand, governmental aid in the accomplishment of this purpose. A Woods, Forests, and Rivers Preservation Department for the United Kingdom should be instituted, and an Act passed having for its object the governmental direction of the country generally, and the imposition of powers over owners of land to compel them to reforest hills and uplands being the sources of streams and rivers, and to replant river banks, and do other things necessary to the maintenance of the natural storage and sufficient supply of flowing water throughout the country.

The streams and river channels of the country, the aggregate length of which in England and Wales alone amounts to, roughly, 200,000 miles, are, as we said, silting up very rapidly.

The work of restoring the natural beds to all the lengths of rivers and streams of the country will of course be a very considerable undertaking, and will require much time for its accomplishment, as well as a colossal expenditure of capital. As a set-off against this, however, we may safely affirm that it will be in every way remunerative, and will promote the health and happiness of the present generation, and of generations to come, while it will distribute wealth throughout the country, and lessen, if not altogether neutralize, the undesirable ardour of the working classes to flock into and crowd the towns.

The silt, as the accumulated material upon the beds of rivers is called, can be turned to very useful account. Formed, as it is, by the washings from the fields and uplands of the catchment areas of the rivers, and becoming intermixed on its passage to the rivers and streams with decaying vegetable refuse, it will obviously constitute a splendid top-dressing for meadows, pasturage and other agricultural lands; much of it may be utilized for pottery and brick making, while a large portion of that accumulated in the more rapid and hilly streams will be suitable, without preparation, for macadamizing roads.

But it is not enough to free our river channels of deposited material. We must take measures calculated to maintain the bed of the river, when restored to its natural condition, in an unimpeded, cleanly, and unhindered state. This is to be effected chiefly through the agency of *trees* and underwood. The importance of trees as sanitary agents in this connection can hardly be over-rated. We cannot dissever the tree from the river, the one supplements the other; and the tree is as necessary to the existence of pure flowing water as are the springs and affluents, by the unaided action of which the river is very generally, but I need not say very erroneously, supposed to be maintained.

The stream, let us therefore insist, cannot exist and its flow be maintained in a natural condition, nor can it be depended upon as a source of supply of pure water in dry as well as wet weathers, without a proper distribution throughout the country of trees.

This is an axiom with all who have carefully and thoughtfully considered this matter, and it ought to be impressed upon all dwellers in the country, as well as upon those—indirectly but vitally interested—whose occupations betake them to the cities.

The votaries of religions antecedent to Christianity were jealously careful to preserve large vegetation upon the uplands of their countries.

The Druids in this country kept the hills well forested; and in India the Brahmins left their forests intact at the sources of their rivers and streams, and here they built temples in honour of their gods, and here they worshipped according to their lights. The great Israelitish law-giver, Moses, was equally solicitous about trees, and philosophically and realistically declared to his people that "*the tree of the field is man's life.*" And man's life it may well be said to be; for we invariably find that man thrives

and prospers most in those regions, and in those alone, that are well wooded. It is not sufficiently considered that large districts of Africa, Asia Minor, and other desert regions, require only a well supervised system of *reboisement* to render the country as habitable and as healthy as any part of the globe. The effect of preserving vegetation upon uplands that constitute the partings between the catchment basins of rivers, is that the rain, when it falls, instead of running off at once and forming temporary and transient and injuriously rapid streams, lingers in the foliage, and continues to be a source of gradual and continuous supply for days, and even weeks, to the neighbouring streams.

And rain water is still further held in check by the roots of grasses, bushes and trees, with the effect that it gradually filtrates through the sub-soil, and traversing a downward course, in time finds its way into the stream, after having moistened the intervening soil and helped to supply the needs of the vegetation in its path.

And besides, the extensive leafy surface favours evaporation, and thus keeps up a natural atmospheric moisture, which contributes to the descent of rain, when clouds, blocked in their passage by high vegetation, linger upon the hills.

Then the fall of leaves and seeds and seed pericarps, and decayed blossoms and branchlets of the trees, will in course of time supply the place of the humus washed down by rains from hills that have been denuded. Thus the hilly countries, which by our neglect, our christian neglect, are in many parts of England, but more a great deal in India, rendered waste and unfertile, can, by the natural operation of trees, be restored to their pristine condition of fertility, by the acquisition of a fresh and well-manured soil.

The holding-back influence of trees before alluded to upon rain water, must necessarily afford a suitable opportunity for the underground absorbent strata to become saturated, and hence they constitute an indirect origin of springs. Indeed one of the commonest sights in the country is the beds of dried up springs, where woods have been extensively felled, and the ground cleared of trees and underwood. It is evident, therefore, that if we wish to have a continuous and sufficient flow of water in our river channels, and to lessen the causes contributing to overflow or flooding, we must create and secure a surface capable of retaining rain water in our hills and uplands; and this object is best secured by the agency of trees and forests, and luxuriant herbage.

It is obvious also from what we have stated, that not alone will the rain be better retained, but its fall will be greatest upon the hilly portions of the country that are under forest. Forests also prevent the accumulation of silt in rivers, for they keep back the earth and sand and stones, that would otherwise be washed down from the hills into the water channels.

It is necessary for the conservation of our rivers that trees should be planted, not alone upon the hills but along the river banks. Here, by their roots, they not only increase the height of, but give firmness and cohesion to the banks; prevent the washing in from the river-sides and neighbouring gentle uplands of clay and sand; and by the promotion of the porosity of the soil through the agency of their roots, the good effect upon the adjoining lands of the lateral pressure of the river water inland is secured, thus giving a continued supply to the sub-soil moisture, necessary for the nourishment of grain crops and other forms of vegetation.

More than in any other country, the rivers of England discharge their waters into large estuaries of the Ocean—the Thames, the Severn, the Mersey, and, in Scotland, the Clyde, are examples of this. Upon these estuaries the silted condition of all our rivers is at the present moment exerting what might appear to be a paradoxical influence. The estuaries are becoming less capacious in depth but more extensive in area; and this not so much in consequence of the agency of ocean water as from the lessened activity of our inland water streams. The volume of water in our rivers no longer forms a barrier to the entrance of tidal waters up their channels, and consequently the area over which the salt water washes is laterally and longitudinally increasing; while the increased amount of river silt, washed down by conjoint agency of river and ebbing tidal water; and the ocean sands, increased by the additional influx of salt water, are contributing rapidly to the filling up of estuaries imperatively required for the maintenance of our commercial prosperity.

Bars are forming at the mouth of most of the rivers of England, as for example, the Thames and Severn, and the Humber, &c. The enormous loss the country will sustain should means not be adopted for counteracting this is simply incalculable; our stability as a nation, and the very lives of our inhabitants, will be jeopardised by the continued and utterly indefensible neglect of the water ways of the country.

The effect of an inrush of salt water along channels that ought to be filled with pure, clear, fresh, and normal river water, is obviously in every way destructive to vegetation, and not in accordance with the requirements of the neighbouring cities and towns, and cultivable lands.

We have pointed out the absolute necessity that exists for taking into serious and immediate consideration the rapid deterioration our rivers are undergoing, and have expressed the conviction that the maintenance of the prosperity of the

country is dependent upon the control exercised by Government over our fresh-water channels, and the directions given and insisted upon for maintaining a sufficiency and proper distribution of trees and brushwood and forest.

The methods suggested are the natural ones, and would be amply sufficient; nevertheless I find that these proposals meet with considerable opposition.

The opposition to them comes from men who are extremely active in advocating the construction of a succession of locks across rivers, and the elevation of the natural river banks by earth or other artificial embankments.

The effect of locks is to obstruct the natural flow of the rivers, and to create inundations. They lessen the "working" capabilities of the river; hence, the natural current being stayed, an opportunity is given for the silt to deposit. By the construction of locks we simply convert a channel that is intended by nature to be the storage area of clear fresh and gently but continuously flowing water, into one in which the water is insanitarily stagnant and inferior for the supply of drinking water to man and beast.

Then the banking up of rivers is attended with consequences even more unsatisfactory; for, if we bank up a river without removing the silt, and thus restoring the natural bed, we raise the level of the river itself; and if we do this, obviously the water from the river will percolate through the thin embankments from the river on to the fields, the position of these being thereby rendered more dependent than the river itself; while if, previously to banking, we remove the accumulated silt, it is impossible to conceive what advantage we can gain by elevating the banks, as in most of our rivers the silt occupies three and four times as much space as does the average volume of river water.

We require in this, as in most other things, to imitate nature, and to understand her methods of working; and we must insist upon it that the health and happiness and safety of the community will be imperilled if the rivers of the country are not kept in an efficient and satisfactory condition.

As sanitarians, therefore, it behoves us to warn the Government of this country, and of every country, of the destructive and devastating effects that must surely succeed the continued neglect or improper management of water-channels, and of the happy and comfort-giving consequences of the adoption of a simple, intelligent, and plainly evident policy, having for its object the clearing out of a country's water-ways.

Mr. Baldwin Latham, M.Inst.C.E. (London), remarked that he could not endorse the statement made as to the influence of trees upon the river. There was no doubt some connection between the rivers, rainfall, and the trees. He had for some years been making observations upon the temperatures of trees, and the conclusion he had arrived at was that trees had no influence in producing rain. If trees were planted upon the hills the trees increased the altitude, and the higher the hills the greater was the amount of rainfall; and it was certainly in this manner that trees influenced the rainfall. Then there was another thing to be said of trees—that they were colder in summer and warmer in winter than the surrounding atmosphere; and these changes or differences which occurred in the atmosphere influenced the rainfall, and tended to increase the rain, when the other conditions were favourable to it. Dr. Cooper had referred to trees as purifying the river. Had Dr. Cooper ever noticed that trees which stood on the banks of a river dropped their leaves into it, and that thus the leaves became a decaying and putrifying mass of vegetable matter, and by their decomposition produced impurity in the water? With respect to the carbonic acid question, he remarked that the largest amount of carbonic acid in the air was present when lands were uncultivated and at the highest altitudes, and its influence was felt in the rainfall in dissolving the hills, and bringing down the material from the high parts of the earth into the rivers. The evils of navigation on adjoining lands were more than compensated for by the increased value of the land arising from improved means of access.

Mr. G. J. Symons, F.R.S. (London), said he was rather disappointed with the paper, and considered that its title was its best part. They had before them the condition of the Yorkshire and Lancashire rivers, which were in a terrible state as far as the river channels were concerned. Dr. Cooper did not say one word about these things, nor did he dwell upon the fouling of streams by the population living upon their banks. Something more than mere Acts of Parliament was wanted to get our rivers into anything like a satisfactory condition, and that was the influencing of the whole population. With respect to the questions of trees and rainfalls, the speaker recommended them to study the book of Mr. Marsh, where he entered upon the whole subject.

Dr. Percy Frankland (London) stated that the atmosphere at high altitudes was remarkably rich in carbonic acid, owing to the absence of vegetation. Thus the proportion of carbonic acid present in the air at the summit of Mont Blanc had been found to be as great as that in the air of London, both being markedly in excess of that in ordinary country air.

On "The Collection and Storage of Rain and Drinking Water, with a description of a system for carrying out the same," by Surgeon-Major R. Pringle, M.D.

With the marked attention lately drawn to the sources of the water supply for urban and rural districts, and the best mode of collecting this supply, the subject of the storage of the drinking water portion of it, whether as obtained from waterworks adopting Artesian wells as their sources, or collecting and filtering the rainfall over given areas, is one that must, in the not very distant future, engage the serious attention of the authorities; for, though the aim of all modern sanitary measures appears to be to secure what is termed a "constant supply," yet there are some localities where from various causes this constant supply is not practicable, and others where, though practicable, it is not a wise measure on which to be entirely dependent, because it is possible that, in an emergency like the following, defectively stored water may be had recourse to for drinking purposes, and that among young men hard at work, and probably partaken of when exhausted, and the system peculiarly susceptible to typhoidal poisoning of a most fatal type. The instance I allude to was as follows: having occasion to visit a large establishment in the South Eastern circle, employing upwards of one hundred men, I asked what arrangements had been made for drinking water when the constant supply was cut off, owing to the bursting of a large pipe, and was informed that the water stored in the cisterns for sanitary purposes had been used on that occasion for drinking water!

I am well aware that the great objection to cisterns of any kind, in relation to the reception or storage of drinking water, is the difficulty of keeping them clean, and it would appear that on this account all attempts to improve the present system of cisterns, with a view of increasing and maintaining the purity of the water they contain, have been abandoned. In proof of this, in the International Health Exhibition of 1884, there was not, excepting my own, one single cistern (unconnected with filtration, which mode of purification mine never undertook) designed with the aim of securing the above requirements, and I therefore only obtained a silver medal for mine because there was no competition. Such being the case it is not unnatural that the attention of all sanitarians has been centred on the *constant supply* as the one and only way of getting rid of that which *seems* to be not only very defective but *apparently* incapable of improvement.

Water drawn from Artesian wells, such as those sunk by the Kent Water Company, might possibly be used by the constant supply delivery for drinking purposes, if there were no filtering beds, without the intervention of any cistern to act, not as a filtering, but settling chamber, but this can hardly be advanced in favour of all the water supplies for London, some of which, instead of pumping their water, as the Kent Company do, from nature's unpollutable and inexhaustible subterranean reservoirs, merely collect the rain-fall drawn from a given open surface, or the same as supplied in a gathered form, by means of a stream or river occasionally themselves of questionable purity; in all these latter water supplies, whether served out in what is termed a "constant supply," *i.e.*, a supply always available after passage through a registering meter, or "intermittent supply," *i.e.*, a supply daily admitted into the storage cisterns for a fixed time each day, a settling chamber would be a great desideratum; but no cistern or tank, into which the water is admitted by a ball valve cock *from the top*, can ever be a settling chamber; yet I hope to be able to show that the principle I advocate, by means of the addition of the "sursum" automatic water purifier to the present water fittings in the ordinary cistern, or tank, as shown in the patterns now exhibited, can supply this at an outlay within the reach of all, and thus convert cisterns and tanks in present use into settling and storing chambers, applicable either for the constant or intermittent supply.

The action of this settling chamber, in the case of the water supplied by the Metropolitan, and all other Water Companies whose supply is gathered from surface rain-fall, either directly from selected watersheds, or indirectly from streams or rivers, and then, after filtration, is distributed for drinking purposes, would only be such as would admit of any impurities, unarrested in the filtering beds, or generated in the mains by "dead ends," and then forced through the service pipes into the household cisterns, or storage tanks, being enabled to rest on the "tranquil bed," on the floor of the cistern or tank.

Once here, these impurities could not pass into the body of water in the cistern, and thus into the drinking water supply of the household, either by the constant disturbance of the constant supply, or that caused by the daily admission of an intermittent service further from this tranquil bed, by the simple process exhibited in the model now shown, which was in the International Health Exhibition, London, 1884; these impurities can be removed without interfering with either service.

As regards the collection of the rain-water from the roofs, some such settling chamber seems to be almost an absolute necessity, for, though a filtering chamber is frequently attached to many underground storage tanks for rain-water, yet the impurities met with in this water, such as soot, &c., owing to the manner in which the rain-water is admitted into these tanks, cannot, by any present system of filtering or settling, be so removed from the point of withdrawing the water as to admit of its being collected in the vicinity of large towns, sufficiently pure or clean to be available for any domestic, and certainly not for drinking purposes.

The water collected from each shower of rain, when admitted into the tank, disturbs that which has begun to settle; and, except when a considerable time has elapsed between the showers, the water collected is but rarely fit for any practical use, and thus, with the increase in houses, and their consequent additional smoke and soot, the collection of rain-water has now been very generally abandoned in the suburbs of large towns, as worth neither the trouble nor the expense. Such was remarked to me when I came to Blackheath upwards of two years ago; but I was satisfied that the principle I had employed for the collection and storage of water from the hill-side streams in the Himalayas many years ago, as the drinking water supply of one of the largest Sanatoria in India, would succeed in the case of rain-water collected from the roofs even on Blackheath, and my expectations have been more than realised. The samples of the rain-water now exhibited were collected by the application of this principle to an ordinary cistern through which the rain-water pipe passed, and the deposit from the "tranquil bed" of this settling chamber, and the substance which floats on the surface will, I think, be conclusive evidence, that a cheap, simple, and efficacious mode of automatically purifying rain-water has been arrived at.

Here I would draw attention to a valuable paper read at the Croydon Congress of this Institute, in October, 1879, by H. Sowerby Wallis, Esq., F.R.Met.Soc., entitled "Rain collected from roofs considered as a domestic water-supply." Mr. Sowerby Wallis in this paper shows the vast importance of this subject in the following instructive sentence, to which I should like to draw marked attention: "We are entirely dependent on rain for our supply of water; for, whether we catch the water which falls on our roofs, or obtain it from shallow or deep wells, or from streams and rivers, it is nothing more or less than rain." Though this was written only seven years ago, yet the subject of water-supply has in that time advanced with strides or rather bounds, which can only be calculated by a reference to the enormous sale which popular works on the water-supply question, written by such authorities as Sir Francis Bolton and others, have obtained.

Without doubt the International Health Exhibition of 1884, and the conferences then held on the subjects of water-supply and sewage disposal, gave an immense impetus to the study of these most important subjects, illustrating in a marked manner the foresight of Albert the Good in 1851, and holding up to all Europe the inseparable connection between the following, as regards the health, and, indeed, as was proved in the case of Naples and Spain in 1884 and 1885, the wealth of nations, viz., the intimate relation between the health of a city and its water-supply, and the sewage of the same and its disposal.

The more the question of sewage disposal is pressed the more are we driven to the two great sources of water, viz., nature's inexhaustible and unpollutable reservoirs, in this country underground (though in the Himalayas above ground also, as in the glaciers) and the rainfall from roofs. The former was remarkably illustrated at Brighton during the Congress just concluded of the British Medical Association, when, thanks to the kindness of the Water Company, opportunities were granted for a careful study of their most remarkably instructive, indeed, wonderful waterworks, designed and carried to such a state of perfection as to leave nothing to be desired for supplying the wants of that "Queen of Watering-places," under the head of water-supply. The latter, though in certain localities of limited rainfall, neither so equally inexhaustible, nor yet unpollutable, is nevertheless, when viewed as a whole, in these sea-girt islands of the ocean, if collected, very considerable, and if carefully stored, remarkably free from impurities; while the most visible and chief of these impurities, viz., soot, in the settling chamber alluded to is, when automatically washed, made to act as a valuable antiseptic to the whole body of water, and also, when collected from the surface of this water, a marketable commodity with a recognised fixed value, as the basis of a superior black pigment and as a very pure carbon.

The great interest now attaching to the question of the disposal of the sewage, not only of large centres of populations but even of small towns, and the general desire to employ it for good instead of throwing it away to be a source of danger to the public health, or an inexcusable waste of valuable substances, bring into marked prominence the subject of the storage of the great natural source of the water supply, viz., rain; but unless our present knowledge of sewage transformation is greatly improved, it may for the present be found better to waste without injury, than utilize with risk to health. It is idle, if not criminal, to shut our eyes to the great risk to the public health incurred by even the simplest and most common effort made with the double view of disposing of and utilising this sewage matter—I mean the employment of the contents of the ordinary cesspool in rural districts. The manner in which this is done in some places would undoubtedly account for much of the sickness brought to large centres of population by the milk.

Nor are all of the extensive and costly systems of water-supply for cities with populations of over 100,000 quite free from this risk of danger to health. One instance comes to my memory in which the rainfall over a given area, aided by the dammed-up waters of a hill stream, constitute, after passage through filtering beds, the water supply of a large manufacturing city. On the banks of this stream during its course to this dam are more than one village, the entire surface drainage of which can only be into this stream, while the other sanitary arrangements are not such as to add to the purity of this water.

Again, what kind of manure is thrown over the fields which make up the watershed of this or any similar collecting basin? In short, the more the subject is gone into the more the proper value of rain-water becomes evident. And as there are few cities who can fall back upon a Loch Katrine to supply its wants as Glasgow has, so it becomes all those whose water supply is liable to pollution by any means traceable to this matter of the disposal of sewage, to see to it before an epidemic directly results from that which should never have been originally permitted. I repeat, therefore, the denser the population on the land the more need to go deeper to Nature's reservoirs for the water, or higher for the origin of all, viz., rain. The deeper we go for the water by means of Artesian wells the more we limit the supply in the vicinity near the earth's surface; for an Artesian well, as has been amply proved lately, gradually exhausts the water supply of the little wells above it, until they have to be abandoned altogether. True, the Artesian well amply supplies the place of the abandoned ones, but while the water drawn from these now dried up wells cost nothing but the pumping, a water rate is now placed on the water withdrawn from them, and its use rendered compulsory. Thus again are we driven to the importance of rain-water storage whenever practicable. In India, for instance, in places where pure water is scarce the natives adopt a simple but very effective plan for collecting and storing the rain; viz., a large sheet tied to four stakes, and a little stone put in the middle for the water to be drawn to the centre, and thus fall into the earthenware vessel placed below to receive it and convey it to the storage jars.

Mr. Sowerby Wallis, in his paper, enters into full details of the rainfall and its distribution in this country, but to one who has resided in the Himalayas as I have done for many years, and seen the mighty factor that snow proves itself to be in the storage of water, it will be evident that in many places, even in this country, the snowfall is a valuable addition to nature's water-supply for this earth, not only as it falls but as it gradually melts, and then passes into her great reservoirs to which allusion has been made, and this it does gradually and surely, differing in this respect from a heavy rainfall, which flows off the land into the drains and rivers and thence into the sea, with but little storage having been effected in this hurried passage to its visible but temporary bourne.

The snowfall of January, 1886, gave me opportunities of making experiments on this subject to an extent which rarely occurs so far south in these islands, and I am satisfied that the freedom of this snow-water from leaves and other impurities, and the *possibility of removing the soot*, makes the snowfall a valuable addition to the water available for storage in underground tanks.

It would take up too much time to enter into the details of the important part snow plays in adding her quotum to the water-supply, but its value is very evident to those who have studied the subject in the Himalayas, where specially favorable opportunities are afforded for this inquiry, not only among the miles of glaciers, where, as the Psalmist sings, the Creator "layeth up the depths in his store-houses," but among the hill-side streams used for irrigation. The agriculturists of these mountains sow their fields, not according to the rainfall but the snowfall, as it is the gradual melting of the latter which feeds nature's reservoirs, from whence most of the hill-side streams alluded to flow. In many instances the sources of these streams are visible, and are found to be due to a remarkable natural syphonic action, which, in reality, is *nature's automatic flush*, by which her reservoirs are kept flowing at a fixed rate from six to eight months, *i.e.*, between July or August, and March or April, according to the capacity of the reservoir; for, though the date of the first burst of the water-flow is regulated by the amount of the snowfall in the winter acting on the ordinary rains, the period over which this flow extends in a fixed quantity is limited to within a few days, for the flow ceases with the same fulness and suddenness with which it began.

In calculating the rainfall in this country, and especially in the suburbs of large towns and cities, we must bear in mind the important part the late increase in roofing with slate has upon this collection, the capillarity of slate, as compared with tiles, is reduced to a minimum, while the absence of lime in the water

collected from slates is of great importance, and thus a greater amount and a purer quality of water is now capable of collection, from the roofs of the vast majority of houses, not even excepting the labourer's cottages, than could be hoped for thirty or more years ago. The picturesque thatch in country villages is now fast disappearing, before the wonderful development of the slate trade, and here the benefit of a good system of collecting and storing rain-water will be at once visible, and gladly taken advantage of, if the principle is only *cheap*, *simple* and *effective*. Undoubtedly, the late stringent regulations regarding the smoke nuisance caused by furnaces, have considerably reduced the amount of soot in the air, and on the roofs, and thus to a certain extent greatly facilitate the satisfactory storage of rain-water from the roof, if the sediment or impurities in the water could be allowed to settle, but this is impossible with the present system of admitting the water *from the top*. Again the kind of roof has an important bearing on the quantity of soot to be purified, though few roofs could be more unsatisfactory under this head than the roof of my house at Blackheath, with the water from which I have carried on my experiments since 1884. This roof is a V-shaped roof, closed at one end with a wall as high as the highest point of the roof, thus really converting my roof into a kind of soot trap. At present very few roofs are constructed on this pattern, though once it was a fashionable style for the frontage architecture of houses; the present prevailing style however is the ordinary sloping roof, from which soot is easily blown away, and finds very few places to lodge in; the difference between these kinds of roofs as regards the amount of soot in the rain-water is very considerable, and I enter into these details, as they aid in showing the severe test to which my system has been subjected.

The following is the system I have adopted, and it was exhibited in the International Health Exhibition of 1884, where it took, as I have already stated, the highest and only award, viz., a silver medal. In that Exhibition the system was exhibited with reference to the ordinary drinking water-supply, and in the Exhibition of this Institute at the Leicester Congress last year, owing to the absence of rain when the jury were examining the exhibits, it could not be seen at work; in the present Exhibition, however, it is exhibited as attached to an ordinary rain-water pipe, and, with the aid of the miniature barrel now shown, I will try and illustrate it. The chief feature of the system consists in leading the water on admission to the floor of the cistern or tank, by means of the addition (now exhibited and patented as Pringle's patent "Sursum" automatic water purifier) to the present water fittings, and then turning it up in the centre, so that the water escapes upwards about four inches from the bottom, from whence also it is withdrawn for use. Above this outlet is placed a shield, the concavity of which is regulated in household cisterns according to the pressure in the service pipes; but for rain-water as collected from roofs with three-inch pipes, it need be very slight with a diameter of nine inches for a sixty or one hundred gallon tank or barrel, and twelve inches for larger tanks with four-inch rain-water pipes. The removal of the soot and the purification of the water take place automatically in the following manner:—The soot in the rain water, in addition to any blows it receives at any angles in its passage from the roof, is, on its arrival four inches above the floor of the cistern or settling chamber, forcibly driven against the shield; the effect of this action under water is to divide the soot into cinder and pure carbon, and while the cinder falls, and rests in the "tranquil bed," the carbon escapes to float upwards to the surface, where it gathers in much the same way that lamp black (which in many points it closely resembles) collects on any surface placed over a flame, the combustion of which is very imperfect.

This truly coal or "sursum" black as I have called it for distinction, which rises to the surface through this four feet of water, is thus exquisitely purified, and while passing through the water is in such minute portions as to be invisible to the naked eye, except as a slight tinge in the water, when placed in a pure white china cup, but is not visible when examined through the sides of an ordinary glass tumbler.

The substances which I now exhibit are these two chief constituents of ordinary soot separated by the principle just described, and I repeat that this cleansing is purely automatic, going on without any interference being necessary, or interruption experienced.

There is in this system another remarkable automatic action, which is well illustrated by drawing the water off at three different heights, viz.: 1st, at the bottom tap four inches from the floor; 2nd, at the tap half-way up the cistern or barrel; and the 3rd, from the top on a level with the overflow, after blowing aside the thin layer of coal black, which collects like a very fine scum on the surface. If this withdrawal is done by means of three tumblers it will be seen that the water is purified from above downwards, *i.e.*, the purest or most settled water is obtainable from the top, the next from the middle, and the most unsettled from the bottom tap.

The effect of the water on its entrance striking against the shield, automatically produces this purifying action, which acts further in lifting up the body of water in the cistern or barrel

by that last admitted, and thus, if the supply coming in is sufficient, all the water previously collected is removed by the overflow, and its place taken by the product of the last shower. In the case of an underground storage tank, this displaced water would pass into it by the overflow, in the same manner in which it was admitted. Thus settled and purified rain-water would alone pass into the large storage tanks, into which nothing could pass which had not been subjected to this automatic purifying process, and the cistern or barrel would thus be used as a settling and purifying tank, while, if necessary, it also might be tapped to meet daily wants, and any surplus or excess of rain after purification would pass into these large storage tanks underground. The floor of this settling chamber or cistern might be cleaned as often as necessary, by gently stirring the floor and then suddenly withdrawing the plug; this at once removes, in the rush, the cinder and other sediment too heavy to rise far from the floor, and admits of a little clean water descending to occupy the place of that lost in cleaning out the floor of the cistern.

This simple process of cleaning can be done when a shower of rain threatens, and thus the loss of water is reduced to a minimum. The testing of the condition of the floor of the settling tank for the service or rain-water can be effected at any time by simply stirring the sediment at the bottom and then drawing off a little water at the bottom tap before it has had time to settle. With reference to the cost, a most important point if the poorer classes are to be benefited, I may mention that a barrel for water, holding sixty gallons and fitted with two good taps, and this system of automatic purification can be made, all charges included, for sixteen shillings, or the apparatus alone for five shillings for a three-inch pipe, and a slight increase for pipes of larger measurements. For permanency and economy in the end, a light galvanized iron tank to hold sixty gallons would be the best and could be purchased at present for, comparatively speaking, a small sum. In the construction of a tank or cistern to act as a settling chamber for the purification of rain-water, before it passes into the storage tanks above or under the ground, it is always preferable to have the cubic contents in the height instead of the width, *i.e.*, to construct the cistern or tank more resembling a barrel in height, than an ordinary cistern in width, as the barrel conformation facilitates the automatic purification of the water by securing the perfect settling in the tranquil bed of the cinder in the soot, and other roof impurities, and thus increasing the purity of the water escaping by the overflow for storage.

After trying various expedients to remove, or rather arrest, *at once* this fine carbon passing upwards to the overflow in the otherwise settled rain-water, I have found the following very cheap and simple mechanical filter effects this arrest very satisfactorily, and except under the conditions alluded to hereafter, sufficiently clears the water for drinking purposes: An ordinary thick glass cylinder, $1\frac{1}{2}$ inches in diameter and eight inches long, with one end contracted to half an inch, and the other end turned slightly outwards to hold the elastic tube; after passing a small piece of sponge into the narrowed end the cylinder is filled with granulated animal charcoal, and another sponge is put in at the top to keep the charcoal from falling out; over this an elastic tube is passed and, when the other end of the tube is passed over the centre tap in the settling chamber, the water is turned on. The purifying action is only mechanical, and the two sponges and rough charcoal arrest the minute particles of carbon, and clear water is drawn off.

This mechanical action is well illustrated by the carbon gradually almost closing up the filter, so that the water at last only passes by drops, whereas it at first flowed freely; to prove this still further, if the two sponges and the charcoal are removed, and all washed in a basin of water the carbon quickly leaves the charcoal and floats to the surface, passing over the edges if more water is added, and a few squeezes of the sponges *under water* force out the carbon, which also floats away; and when sponges and charcoal are replaced as before, and the cylinder is re-attached to the tap, and the water turned on, it will be found to flow as freely as it did at first. I enter into these details, as I think they will admit of a similar filter being made at a very moderate cost, the one I now exhibit being that which I have just described, and it cost only one shilling. I do not wish it to be understood, that the system I recommend will effectually remove all roof impurities carried down the rain-water pipes into the storage cisterns or tanks, but merely, that it will place these impurities as far as possible out of the reach of passing into the water drawn off for domestic, or passing off for storage purposes, by permitting them to rest in the tranquil bed, and here to remain undisturbed either by any more roof impurities passing through the water downwards, or the constant disturbance produced by the admission of the water collected, it may be from a passing shower. There is however one species of roof impurity which I consider must seriously interfere with any attempt, either at purification or storage. I allude to the droppings of pigeons on the roof, though, if any substance will minimize the injurious action of these and similar impurities, it is the constant passage of minute portions of a deodorizing and antiseptic substance like carbon through the water.

A necessary warning appears advisable here, viz., that lead should in no way be brought into contact with the rain-water, as from some experiments I made by storing water in a glass cistern, with a standing overflow lead pipe fixed at the bottom of the cistern, I am satisfied from the special opportunities the glass sides of the cistern gave me of watching the action of this rain-water on the lead, that its injurious effects must be not only very considerable, but very rapid; fortunately zinc or galvanized iron can completely supplant lead, without the slightest risk of any injurious action resulting.

A late writer in a popular periodical describes the London water-supply as follows: "The most characteristic feature of the London water is its hardness." And such being the case, the value of collecting rain water for washing purposes, not for clothes only, but for the skin, is self-apparent, but the "London blacks" have hitherto put an effectual barrier on the attempt; if, however, they can be overcome, there can be little doubt the collection of rain-water would be readily undertaken. Indeed in many suburban residences attempts are even now made, and I have known, among the poor washerwomen, of an old sack being tied to a rain-water pipe in hopes "to stop the blacks." Some of us may also have seen water in white china basins into which we almost hesitated to plunge our faces, fearing they might come out, even on our return from London blacker than they went in.

While on the subject of soft water for washing, I may mention that the very hard water of the Kent Water Company, and other companies drawing their water from the chalk strata, very often produces in children, and sometimes in adults, no matter what soap is used, an eruption on the face and hands, due to the lime in this water, and its action on the skin, when cold or east winds have to be encountered; this has sometimes been mistaken for a constitutional disease, for which various internal and local remedies have been given and applied, but which a little rain-water has completely removed.

In conclusion, I would only state that the coal, or, as I have termed it, "sursum" black (to distinguish it from the bone, lamp, spirit, and gas black of commerce) which I now exhibit and which can be collected in quantities varying with the amount of soot in the air, from the surface of this settling chamber, or when dried from the bags fastened over the pipe of the overflow, has a distinct marketable value, and, in point of density of colour and purity, is superior to the best black of commerce, viz., spirit black, gas black being so little collected that the supply cannot be relied on. The superiority of the "sursum," or coal black, need not be a matter of surprise, the process of purification it undergoes, and the minute division in which it passes through a body of water varying from 3 to 4 ft. in depth to float on the surface, must, I think, place it, when compared by the ordinary methods of comparison with other blacks, in a high class as regards purity, minuteness of division, and hence lightness, freedom from grit or cinder, hence facility and thoroughness of mixing, and intensity and deepness of color.

The cinder, as collected from the "tranquil bed," when thoroughly dried, has also a marketable though inferior value, as it is only applicable for the coarser kinds of black paint. I would close by adding that it seems certainly a new and favorable point from which to view "London soot," viz., as containing a substance capable of forming the basis of a black pigment superior to that of any similarly-prepared pigment in the market and a carbon of great purity—all to be done automatically, without further expense, trouble, or interruption, and thus possibly to prove, as in the case of the refuse of gas coal, "a valuable residual."

LECTURE TO THE CONGRESS,

BY

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

THE object of the Sanitary Institute in holding an Annual Congress is to endeavour to excite the interest of the community in sanitary knowledge; and I do not think that I can occupy your time more usefully this evening than by drawing your attention to one of the most valuable pieces of work which the Sanitary Institute performed last year, and which bears a special relation to the question of the prevention of disease, viz., the publication, under the auspices of the Sanitary Institute, of *Selections from the Reports and Writings of Dr. Farr, on Vital Statistics*, under the editorship of our eminent member, Mr. Noel Humphreys.

Dr. Farr laboured successfully, in forwarding the science of vital statistics, for little short of half a century. Indeed, I may say that in this country no one has rendered a greater service to this branch of sanitary investigation than Dr. Farr, and the pages of Mr. Humphreys' collation of Dr. Farr's work are so replete with interest that I trust that the account of some of his views on practical sanitation, which I shall be able to mention to-night, will be the means of inducing many of you to study them for yourselves.

The science of vital statistics lies at the foundation of all accuracy in sanitary research. The national registration of the causes of deaths, which has only been systematically carried on over the whole country since 1838, has given greater prominence to the principles of physic, and has enabled the science of medicine, like other natural sciences, to abandon vague conjecture for facts accurately determined by observation, and to substitute numerical expressions for uncertain assertions.

The registration of the causes of deaths necessarily leads on to further investigation.

For instance, it induces the study of the locality in which