THURSDAY, DECEMBER 23, 1869.

TOWN SEWAGE

ONE of the most imperative requirements of social life is some means of dealing with those waste products of the human mechanism which are dirt only while they remain out of their proper place, but are capable of becoming a source of serious inconvenience and injury whenever they are allowed to accumulate in the neighbourhood of dwellings, especially in densely populated places. In the case of isolated dwellings, and where the population is scattered, no great difficulty would be experienced in devising simple measures for disposing of this refuse so as to meet all requirements. But wherever the population is concentrated, the difficulty of dealing with house refuse, so as to prevent its becoming a nuisance, and, at the same time, to make it useful, is greatly increased. Partly on this account, and partly because neglected accumulations of house refuse are in the highest degree detrimental to health, the measures adopted in towns for dealing with house refuse have been subjected to the control of the municipal authorities, instead of being left to the option of the individual occupiers of houses; and in modern times it has come to be regarded as one of the first duties of such bodies to provide for the disposal of house refuse so as to preserve the health and life of the populations under their care. This sanitary axiom has indeed been forced into recognition by the ravages of epidemic disease, such as plague, fever, or cholera, and it may now be deemed unquestionable, except where ignorance overcomes intelligence, or where mistaken notions of economy prevail.

On sanitary grounds it has been decided, or, to say the least, very generally admitted, that the most efficient mode of dealing with house refuse is to remove it at once from dwellings, and by means of a copious use of water to sweep it away through underground channels outside of towns. In this way the domestic nuisances that were familiar during the early part of this century have been done away with, the town nuisance that arose from the use of cesspools has been suppressed, and the sanitary state of towns has generally been improved. But the removal of those nuisances has given rise to another one, affecting not only individual dwellings and towns, but the whole country. The continuous discharge of vast quantities of house refuse, distributed through great volumes of water into rivers and streams that are often sources of water-supply for domestic use, has rendered them so foul that this result of sanitary improvements is acknowledged to be a national nuisance, and one of the very highest importance in regard to public health.

Hence has arisen the question, What is to be done with town drainage? And this question still perplexes the Government, municipal authorities, river conservancies, and legal tribunals. In many instances the sanitary works carried out in towns at vast expense have given rise to serious nuisances at places lower down the streams into which the sewage is discharged; in other cases the execution of such works is prevented by prohibition against the discharge of sewage, and in some cases practices in direct opposition to legal enactment are tolerated because no remedy seems applicable.

So much for the difficulties attending the municipal object for getting rid of house refuse. It is now necessary to consider the subject in another light, and inquire what is the "right place" where house refuse is no longer to be regarded as dirt, but as material of value? How is it not only to be got rid of, but also turned to account and made useful? For this purpose it must be remembered that this waste material consists of the portions of our food which have done their work in the process of nutrition, and those portions of it which were not required in that process. In both cases plants are the source from which the constitutent parts of this material have been derived. Those plants again have abstracted them from the land on which they grew, not accidentally, but as an essential condition of their growth. Here, then, in this fact that the constituents of house refuse are essential for the growth of plants, lies the key to the sewage problem, a possibility for the utilisation of town sewage. Thousands of tons of the same substances that are constituents of house refuse are annually imported into this country for use as manure in agriculture—ammonia in the guano from Peru; phosphates, or bones and phosphatic minerals, from all parts of the world; potash from South America and Germany. Thousands of acres of land lie unproductive from want of these substances, and some of their most important sources are only of limited duration. Meanwhile the aggregate intrinsic value of those constituents in the house refuse of this country amounts to several millions annually.

There are, however, serious difficulties to be overcome before the economic object of utilising town sewage as manure in agriculture can be realised so as to fulfil all requirements involved in the municipal object of getting rid of it, and in the still more important sanitary object of preventing it from becoming a source of injury to the public health. These difficulties arise chiefly from the enormous dilution of the sewage, partly by the use of water for removing house refuse, and partly by the admixture of surface water and subsoil drainage. Generally speaking, the constituents of town sewage which have an intrinsic value as manure are so much diluted that a quantity of them which would be worth one shilling in the state of a dry solid like guano or bones, containing only a small proportion of less valuable admixture, is in sewage mixed with from six to ten tons weight of water. Therefore, in order to give land an ordinary dressing of manure in the form of town sewage, it is necessary to apply a very large bulk of that liquid. This can very often be done without any great trouble, especially when the town from which the sewage is discharged lies high, and is surrounded by cultivated land at a lower level; and even when this is not the case, the cost of pumping the sewage to a sufficient height, and the outlay for pumping works, would not generally be a serious obstacle to the application of town sewage as manure. However, the getting rid of sewage involves its continuous daily application to land; and here the municipal object is at variance with the agricultural object, of using the sewage only when it is wanted. Consequently, it would be necessary, in organising a general system of sewage utilisation, to establish a new system of farming; to grow crops specially suited for the frequent application of very dilute liquid manure, and to have the land laid out for cropping in such a manner that there may always be a

sufficient area available for disposing of the sewage day by day. Innovations of such a kind are exceedingly difficult to introduce into an art like agriculture, that is practised so much under the influence of tradition and habit; but, in addition to this impediment, there is the more serious one of cost to be incurred in adapting a farm for sewage irrigation. For the farmer, the value of town sewage is to be estimated, not by the intrinsic worth of the substances it contains, but by the amount of those substances which are effective, or at least likely to be effective, in augmenting the produce of his land after due allowance for the influence of season. If sewage containing in each ton twopence-worth of manure be applied to land in such proportion that only one-fourth of the aggregate quantity of manure constituents remain in the land or become effective, then the sewage so applied cannot be worth more than one-halfpenny per ton to the farmer.

It is therefore futile to estimate by calculation, as has often been done, the value of the sewage discharged from a town, and to anticipate, on such a basis, the possibility of making the sewage a source of considerable revenue to the town. Speculations of this kind have naturally eventuated in disappointment and the disgust of all who have been misled by them, without making due allowance for the drawbacks that influence the value of sewage as manure even more than the intrinsic worth of its constituents.

Another circumstance to be taken into account in this respect is the outlay requisite for conveying sewage from the sewer outlets where it is discharged from a town to the land where it can be utilised as manure. Even under the present system of agriculture, farmers would often be glad to have the command of town sewage for application to their land during dry seasons, when the total failure of a crop might be thus obviated. But it rarely happens that this is practicable, owing to the want of any channel of communication between the sewer outlets and the land where it would be useful. Farmers, and even landowners, would rarely be in a position to incur the expense of making such communications, and municipal authorities refuse to do it as being beyond their province. However, if the importance of preventing the pollution of rivers and watercourses were fully appreciated in regard to its influence on public health, there is much reason to believe that the obligation of getting rid of town sewage appertaining to municipal bodies really extends far beyond merely discharging it into a neighbouring stream, and involves a considerable contribution on their part, according to local conditions, towards the outlay necessary for combining the attainment of their special object with that of the farmer by getting rid of the sewage in such a manner that it may be made useful.

It would, at present, be almost impossible to suggest how this object should be realised; for if town sewage is to be applied on the same principle as manure like guano or bones, only in such proportion as to give the requisite dressing of manure constituents per acre of land, the area over which the sewage of a large town would have to be distributed would be enormous, and the attendant expenses of its distribution would be very large. If, on the other hand, the area of land to which the sewage is applied be limited so as to dispose of the largest possible proportion of sewage and keep the cost of arrangements for distribution within the smallest bounds, there would generally be such a disproportion between the actual quantity of manure constituents applied per acre and the possible effect produced on the produce of the land, that the value of the sewage as manure would be greatly diminished; or, in other words, very much of it would be wasted, and still simply got rid of.

Here again sanitary considerations demand attention, and the possible influence which the application of town sewage to land may have on the public health must be taken into account. It is, for instance, indispensable that the use of town sewage in agriculture should be conducted in such a way as to be an effectual remedy for that pollution of rivers which has become a serious national evil. Moreover, if sewage-irrigated farms are to be distributed throughout the country in the neighbourhood of towns, it is still more imperative to know that the adoption of this course will not be productive of injury to the public health. This point should receive the fullest elucidation before any general measures can be taken with the object of utilising town sewage, and the conditions under which that can be effected without risk should be thoroughly investigated.

Such an inquiry would comprise many questions of detail, requiring varied skill, and considerable time as well as labour, for its prosecution; and the British Association Committee that contemplates carrying it out, impressed with the magnitude and importance of the task, has felt the necessity of much larger means for conducting the inquiry than that small sum which the Association were able to grant for the purpose of meeting the expenses of preliminary work. If municipal bodies and landowners respond to the application of the Committee in a manner commensurate with their interest in this subject, and provide adequate funds for thorough investigation, there is reason to expect some considerable step will have been made towards placing the question of sewage disposition and utilisation in a more satisfactory position than it has yet attained.

Besides the main points already mentioned, of getting rid of sewage and turning it to account, there are yet other questions of moment to be considered. The rapid adoption of reformatory methods, in regard to the sanitary state of towns, which has marked the past quarter of a century, has not always been attended with so much improvement as might have been desired. In some instances, serious anomalies have presented themselves in this respect, and there is much reason to believe that circumstances yet remain to be provided for which affect the sanitary state of towns. Mr. Bailey Denton has recently called attention to this matter by pointing out in his letters to the *Times* the fact that, in some instances, the sewerage works of towns have been constructed in such a way as to admit of the soil surrounding the sewer being permeated by sewage, and he has suggested, as a possibility deserving of inquiry, that in this way an effect may be produced similar to the infiltration of house refuse from cesspools into the surrounding soil. If such be the case, it would perhaps account for the fact that in some towns, where every kind of known sanitary precaution has been taken, the reduction of disease and mortality has been but slight. Such an action, though slower than in the case of infiltration from cesspools, would not be less sure in its influence on the sanitary

state of a town, and in that way sewered towns may still be exposed to the evils arising from "excrement-sodden soil" which the Medical Officer of the Privy Council has pronounced to be one of the main causes of cholera and fever.

Another point in which there is reason to believe existing sanitary arrangements are defective is the facility of communication between sewers and the dwellings from which they are intended to convey refuse. Some connection of the kind is indispensable for the use of water as a transporting vehicle for the refuse; but little attention has yet been paid to the fact that the very arrangement which facilitates the water-carriage of refuse also favours the regurgitation of foul gases from the sewers into streets and dwellings. The water traps and syphons commonly attached to the connections between houses and sewers are seldom or never sufficient to prevent the passage of gases; and in this way the inhabitants of sewered towns may be exposed to the unwholesome influence of a constant pollution of the atmosphere as pernicious in its action as the use of water polluted with drainage from cesspools, or living over an excrement-sodden soil, has long been recognised to be.

These are some of the chief points which the limits of the present article will admit of being noticed as being comprised in the inquiry to be carried out by the British Association Committee. BENJAMIN H. PAUL

SCIENCE FOR CHILDREN

THE schoolmasters of the present day may be divided into two categories: those who *teach*, and those who *hear lessons;* the latter class, unfortunately for the next generation, being by far the more numerous. The mischief done to the community generally by the shortcomings of inefficient teachers is too well known to every one who has pierced below the surface of the great question of middle-class education. The difficulties, however, that beset a science teacher in his endeavours to force scientific truths into the unwilling and unprepared minds of boys, who have been subjected to the sway of these same lesson-hearers, can only be realised by those who have gone through the task. The case of a senior science class, which has been under my charge for some months past, will illustrate my meaning most fully. It consists of about a dozen boys, whose ages range between fourteen and seventeen years, and they receive twice a week an hour's instruction on chemistry and physics. The class may be divided into two distinct portions by a perfectly sharp line. Four of the boys have had the advantage of six or seven years' training under the principal of the school, who is not only a ripe scholar, but also an efficient teacher—a very rare collocation in these days. The rest have simply learnt lessons all their lives. The four boys who have been *taught* are as mentally distinct from the others, as if they were different species of the same genus. The first four are bright, attentive, wide-awake—I know of no other term to express exactly what I mean—logical, and clear-headed; they can fairly follow a chain of scientific reasoning, and reproduce it afterwards link by link; they have a certain power of induction and deduction, although of course, being new to science, this power is necessarily only just awakened; they can connect and correlate facts and ideas, they can enumerate a series of phenomena in logical sequence; in a word, although their industry and application are far from colossal, the task of teaching them the truths of natural science is a comparatively easy one. The other boys, as I have said before, almost form a distinct mental species. They cannot understand the possibility of learning anything without the aid of a book, and the idea of finding out anything for themselves has never entered their heads. Still they are far from stupid boys, being all possessed of good average brains; yet their faculties have not merely been allowed to remain undeveloped, but they have been utterly entangled, stunted, and stultified by what Dr. Frankland would call their "previous school contamination." These boys, it must be understood, are the sons of parents belonging to the upper stratum of the middle class, and have mostly been to schools conducted by university men with honourable initials appended to their names—men, in fact, who are scholars but emphatically no teachers. Their great fault is a total want of mental method, without which the greatest brain is as nought. They are at home in Virgil and Horace, some of them are fair Greek scholars; they have "been through" Euclid, and can work moderately difficult algebraical problems in a certain mechanical fashion; they are well acquainted with the leading facts of English history, and know the exact position and population of Adrianople; but as far as real mental power goes, any poor boy, who has been in a National school for three years, would beat them hollow.

These facts surely point out the absolute necessity of beginning scientific training at a very early age; and I fancy this necessity has not been sufficiently dwelt upon in the numberless essays, letters, lectures, and evidence on the subject of scientific education with which we have been deluged during the past decade. There seems to have been a notion abroad, that scientific teaching should not be begun before the age of 12 or 14; but why, I would ask, should boys' minds be allowed to remain fallow during all these years? The minds of boys of 7 and 8 should surely be as carefully developed as those of their seniors, and there is certainly no means of pure mental culture so successful as scientific teaching. A boy of this age should not be taught science so much for the sake of acquiring a certain number of facts, as of developing his powers of observation and reasoning, and giving a proper tone to his mental faculties. A boy of 8 or 9 takes a morning canter of three or four miles on his pony, not for the purpose of getting over some 7,000 yards of ground, but to strengthen his muscles and improve his carriage: his science lesson should be an intellectual canter, taken with the view to strengthening and improving his mental muscles and carriage.

In National and British Schools, and in some few middle-class schools conducted on rational principles, this great want is supplied by what are known as "Object Lessons." A natural object, such as a piece of lead or sugar, is placed before the class, and its physical properties are described by the pupils with the aid of questions from the teacher. Its origin and manufacture are also given in the case of the older children, and the whole is noted down on the black-board in as condensed a manner as possible; the lesson being reproduced in a miniature form either *vivâ voce* or in writing. These lessons are