#### CHAPTER IX.

"The Commissioners shall provide all establishments, cattle, carts, and implements required for the removal of offensive matter and rabbish."—Sec. 193, Act V of 1876. (B. C.)

One of the principal duties of the Municipal Conservancy department is the regular collection and removal of house and kitchen refuse, refuse from markets, shops, and handicrafts, the litter and dung from stables, and the street dust and droppings of animals in the thoroughfares. The cleansing of the streets is a matter of far greater importance than is generally recognised. It affects the public health and the comfort of the community to an important extent. In most towns it is customary to have certain fixed hours, within which such matters may be deposited outside the gates of compounds and houses, on the side of the thoroughfare from whence they are removed by scavengers' carts. Nothing presents so repulsive an appearance, or is so conducive to the production of foul smells and noxious exhalations as garbage heaps left on, or unremoved from the roadsides, it is, therefore, incumbent on every Municipality to maintain a sufficient staff of carts and scaven-. ger coolies to keep the streets clean and remove daily all such accumulations. In most Municipalities in Bengal\* bye-laws framed under section 313 of the Bengal

The Bengal Acts have alone been referred to, but there are similar reprovisions in all local enactments relating to Municipalities.

## Deposit of Garbage.

Mofussil Municipalities' Act prescribe the hours (usually from 8 P.M. to 8 A.M.) within which refuse may be deposited, and these bye-laws should be strictly enforced for the general comfort and health of the inhabitants. In some towns fixed dust-boxes are placed in the streets, but they are not to be recommended: they are unsightly and soon become *foci* of filth and foul smells.

Dr. Janes, of New York, one of the Sanitary Inspectors of that city, says, "The garbage-box is another nuisance which deserves particular attention : they are generally placed on the side walks, and are either constantly full or never completely emptied. Very few of them are without signs of demolition, many have but three sides, some but two, and not one in the whole district has a cover. It is not unusual to see these boxes day by day receiving their accustomed load until filled to their utmost capacity, the gutter receiving the surplus, which forms a temporary dam, allowing the collection and retention of foul water. No effort is made to thoroughly empty these boxes, consequently more or less foul matter adheres to their bottom and sides, sending off an odour more disgusting, if possible, than it was before the mass was disturbed; thus the boxes become so completely saturated with the liquid portion of their contents, that they become themselves a source of disease."

The deposit of garbage on the road sides and streets is also most objectionable; in the rainy season especially a considerable amount of effete organic matter is washed out of the heap and either carried into the drains or spread over the road surface, giving rise to mephetic odours and adding to the impurity of the atmosphere. A simple and efficacious remedy for this evil would be



to compel every householder to place his houserefuse on the roadside in a tub, box, or basket, leeped inside with clay or cowdung. Such baskets are now, or were a few years ago to the writer's knowledge, used

in Bombay for the removal of nightsoil, the scavenger can then empty them directly into his cart, and the road sides would be kept free from the disgusting nuisance now prevailing in Calcutta, the suburbs, and elsewhere. The form of scavenger cart principally in use is a light two-wheeled tip cart, with shafts, drawn by a pony, galloway, or bullock, very much like the ordinary farmer's cart used in England, but altogether smaller and lighter so as to be adapted for the light cattle procurable in this country, having a carrying capacity of about 30 cubic feet, but if fitted with side rails capable of carrying a higher load of straw or light refuse such as leaves, litter, grass, and the like.

The universal manner of disposing of town refuse in this country is by throwing it into holes, pits, ponds, or low grounds which thus in time are raised to the surrounding level, and reclaimed. This practice has given rise to great controversy, some medical authorities condemning it in the strongest terms, while others are just as positive in its favor. For instance, Dr. D. B. Smith, late Principal of the Medical College, and formerly Sanitary Commissioner for Bengal, says, "There is another conser-

vancy arrangement 'which is deserving of the strongest condemnation.' I allude to the practice of filling up hollow places, broken ground, and even tanks with the off scourings and filth of the city. Probably no more certain method of generating and perpetuating cholera could be devised than this said filling up of old tanks with decaying organic matter." Referring to the proposal to carry out all the sweepings of Calcutta to the saltwater lakes, Dr. Smith says, "I believe it will prove a gigantic and intolerable nuisance. I cannot believe that all the abominable sweepings of Calcutta could be deposited within two or three miles of its eastern boundary, (on land liable by chance to be flooded) without ere long creating an atmosphere of putrefaction and fector such as would drive the inhabitants of Entally either into the law courts, hospitals, or graveyards." This opinion was given in 1869, since which time the very practice condemned by Dr. Smith in such strong terms has been in force, and Entally still stands where it did.

The practice has been in vogue in the suburbs of Calcutta for years, and no evil results have ever been experienced beyond temporary inconvenience. The present Surgeon-General of Bengal, when Health Officer of Calcutta, and who himself followed the practice, says, "Respecting the use of road-sweepings for filling tanks, I find that for some years past, the Sanitary Commissioner for Bengal, Dr. Coates, has adopted it in all provincial municipalities; and the Officiating Sanitary Commissioner, Dr. Lethbridge, urges its continuance during his incumbency. The practice is common in European towns."

Harmless though the practice may be however, so far

as its being a direct producer of disease, it cannot be said to be altogether inoffensive; so long as the sweepings and refuse are dry, no great offence is caused; but during the rains when the hollow gets filled up with water, or if the stuff is emptied into a pond already containing water, the result is often the creation of a serious nuisance. Where it is so, however, it may, in nearly every case, be ascribed to want of care on the part of the persons in charge, for where proper precautions are taken, the deposit of sweepings in tanks, even in populous localities, has been continued for several years without giving rise to serious complaint, or to any known outbreak of sickness, and where any very offensive smell has been caused, it has generally been traced to the improper deposit of dead animals, or night-soil into the hollow.

Where a deposit of the kind becomes offensive, the only remedial measures which are of any real service are, at once to cover the deposit with a good coating of fresh earth, and where there is a collection of foul water at the bottom of the hollow, the addition of a few gallons of cold saturated solution of alum will cause the organic matters in suspension to be precipitated, after which milk of lime may be added, and the air may be cleared of offensive vapours by burning a small quantity of sulphur.

In commencing to fill up such hollows with town sweepings, therefore, the following rules should be attended to.

Do not commence to fill any tank unless the department can guarantee the completion of the work by the setting in of the following rainy season. This is easily as-

# 90 Operations of Tank-filling.

certained by the following calculation. Carefully measure the length, width, and depth of the hollow, and ascertain its cubic capacity; then take the number of cart-loads of refuse available in that locality per day, the number of carts multiplied by their average cubic contents, will give the daily amount available, and this multiplied by the



Tank partially filled with refuse,

number of days from the date of commencement of the work up to the 15th June following, will give the total amount. Where a larger pond or hollow is to be filled than can be done in one season, it should first be divided into two sections, by an earthen bank, wall, or diaphragm, so as to keep the sweepings in the filled up portion from contact with the water in the other, as shown in the sectional sketch above. 2ndly.—All water should be pumped or baled out of the hollow before the filling up is commenced. 3rdly.—No dead animals, slaughterhouse garbage, or fæcal matter should be thrown into the hollow. 4thly.—A sufficient quantity of earth should be carted to the spat or excavated from the bottom or sides and kept in a spoil bank for use in covering the deposit when finished, or at any time should it become offensive. The following suggestions which were framed by the writer for the use of the municipality, of which he has charge, and which were approved of by the Commissioners and the local Government, may be found of use as a guide to others, and are, therefore, quoted in extenso.

### The filling up of existing holes, pits, and low swampy lands.

"Here the municipality may come forward and help landlords and tenants, and in order to do so effectually, I have to propose the following arrangements for filling small holes and pits and raising low swampy lands within bustees and other parts of the township for the mutual advantage of the municipality and the rate-payers. At present not only does the municipality make nothing by, the sale of town sweepings, but it is often put to some difficulty to find convenient places of deposit for them, so that the carts have often to travel considerable distances to dispose of their loads and thus waste time.

"One of the objections to the disposal of sweepings within the town is the difficulty of getting earth to cover the deposit. This can only be met by having earth dug before-hand from the spot where the sweepings are to be thrown. This at first sight would appear somewhat useless waste of labour or somewhat like the Irishman's effort to lengthen his blanket by cutting a piece off the bottom to sew it on to the top; but when it is considered that a trench forty feet by five, by five, will give 1,000 cubic feet of earth equal to a surface area of 1,000 feet, if spread one foot thick, it will be seen that the plan can be advantageously carried out. Then supposing we have a tank of, say, 100 feet long, by 60 feet wide, and average depth of 12 feet to fill up, it would be necessary to cut a trench 10 feet wide by three feet deep all round the tank, as  $320 \times 10 \times 3$  which will give 9,600 cubic feet of earth, sufficient to cover the area of tank and excavation one foot in depth, while 100,000 cubic feet of rubbish, allowing about 25 per cent. for settling, will be required to fill the tank.

"As the owner of the land would be a very considerable gainer'in the improvement of his property, the municipality might fairly charge him say Rs. 100 or about Rs. 16, per 1,000 feet of surface reclaimed. I would make this charge where the tank was over 8, and not exceeding 12 feet in depth, but where less than 8 feet, I would lower the charge to Rs. 10 per 1,000 superficial feet.

"The charges should in all cases be made in advance.

"The work of excavation, levelling, and dressing should be done by the establishment coolies in the afternoon, under the supervision of the overseers, and should be paid for as overtime work at regular earth-work rates; the overseers, jemadars, and peous being paid a percen<sup>2</sup> tage of the amount in proportion to their respective salaries. In order to stimulate the cartmen to work quickly, I would propose to pay them a small sum, say one pie per cart load deposited, a regular tally being kept.

"The advantage to the municipality would be the more expeditious and complete cleansing of streets, the removal of refuse from courts and by-lanes where it now often lies untouched, the increased healthiness of the town resulting from this, and from the suppression of so many sources of malaria, the increased value of taxable property, and the general benefit to the ratepayers in having filthy holes and ponds reclaimed at a reasonable cost, and lands now profitless, made available for tenants or building purposes.

"The value of the sweepings may be put out of the question at present, as they are now of little or no profit."

The advantages gained may be thus summed up.

1st.—A large number of malaria, fever, and cholera centres are obliterated from the map.

2nd.—A source of danger to children and even adults is removed from the heart of the bustees and the sides of the highways and thoroughfares.

3rd.-Valuable sites for either building, trade, or cultivation purposes are acquired at small cost.

4th.—The municipality has facility for disposing of the street refuse without the expense of a long lead.

5th--A considerable amount of assessable property and consequent increased rates is acquired.

In the suburbs an area of one hundred and sixty biggahs, or over 54 acres of land has thus been reclaimed, the value of which would not be less than Rs. 200,000 (two lacs of rupees).

Where lands have been reclaimed in the manner above related, the local authority should place a decided veto against their being used as building-sites or bustee settlement for at least four to five years, during which interval they may be used as grazing ground, gardens, or plantations. After four or five season's cultivation they may safely be built upon, by futs or light structures, which will not require deep excavations to put in foundations. The local authorities in Bengal have ample powers under the Bengal Municipal Acts to control

## 94 Street-watering and Sweeping.

settlement on such lands, and this is a matter that should be insisted upon in all cases.

Street-watering or sprinkling is an important aid to public comfort in towns during the dry and hot season : it not only helps to cool the atmosphere by evaporation, but it lays the dust and prevents it from blowing about, not only to the annoyance and discomfort of the inhabitants, but to the detriment of their health and deterioration of their household property. When we consider what street dirt is composed of, being not only inorganic detritus but bullock and horse droppings. garbage, sewage, and even excreta decomposed by heat and moisture, we can easily understand that even more serious dangers to health may be feared than the bronchial irritation produced by inhaling particles of sand, granite detritus, and other irritating substances, while every Indian house-holder is well aware of the ruinous effects of dust upon farniture and other household appurtenances.

I am not, however, oblivious to the fact that there are strong advocates in favor of dry sweeping of streets instead of intermittent moistening, and their arguments are not without reason. One Indian medical man in a recent note on the sanitary condition of Calcutta says, "Better have the well dried innocuous dust of the roads swept up and collected by dhangurs than fertilise the organic germ-cells of disease by systematic watering." This is no doubt true so far as it goes if the well dried dust be really innocuous, and secondly if it were possible to have it completely and thoroughly removed by sweeping. In America where these questions are dealt with in a much more thorough manner than

95

with us, many sanitary authorities condemn the practice, though others are as strongly in its favor.

Dr. Janes, a Sanitary Inspector of New York city, says, "The practice of sprinkling the streets during the warm weather thereby increasing the humidity of the atmosphere and hastening the decomposition of whatever organic matter may remain on the surface is one directly at variance with the present state of sanitary science. If the streets be regularly and thoroughly swept, they will require no sprinkling; otherwise better suffer an occasional inconvenience from the dust than be constantly inhuling the miasm arising from, this practice."

Dr. Furman, another Sanitary Inspector, says, "The habit of sprinkling the streets with water during the heated term is pernicious and becomes a prolific source of malaria;" and Dr. Burrall also an Inspector of the same city says, "Streets will have the least injurious influence upon the public health when clean, dry, and wide, and running in such direction as to catch the prevailing winds. In order to appreciate fully the unhealthiness of dirty streets, it must be remembered that street dirt is composed to a great extent of organic matter. Under the influence of moisture and the ravs of the sun, this matter is constantly undergoing decomposition, as moisture favors the production of organic changes; streets should be kept so clean as to require but little sprinkling, as this, in the opinion of some of our most prominent physicians, only lays a dust which should be carried out of the city instead of being left to form one of the materials for the generation of malaria."

In fact there is a general concensus of opinion on this subject amongst the Sanitary Inspectors of New York, a city containing between 8 and 900,000 inhabitants, and having a most perfect system of sanitary inspection.

But all this testimony goes more to show that street dirt, whether wet or dry, should not be allowed to remain in the streets but should be removed outside the towns; and the theory propounded is, that organic matter, whilst dry or in a state of desiccation, is innocuous, and requires heat and moisture to develope its noxious properties; and here is where the argument on the other side comes in. The dust containing dormant germ-cells, and dried organic particles, it may be, the evacuations of cholera or dysentery, the specific poison of small-pox derived from the skin; of scarlet fever, derived from the skin, throat, and urine; of measles, from the skin and lungs; may be lifted from the ground and driven along by the wind be inhaled, and having thus found their way into the system, will there find the heat and moisture necessary for the awakening of their latent powers of evil .- Parkes.

Thus it may be, we have simply the choice between two evils, and therefore of two evils we should choose the least; add the undoubted discomfort **ca**used in the dry season from March to June by the constant clouds of dust to the possible injury to health, and the balance is certainly in favor of street-watering combined with scraping and cleansing.

In India, except in some of the larger cities where there is a regular water-supply with street hydrants street-watering is carried on by water-carts or bhisties the latter being perhaps the more common, as it certainly is the more primitive; and after experience of both modes, I am inclined to think, that the agency of the bhistie is, especially where tanks are not situated immediately on the roadside, the cheaper and more effectual. The bhistie's mussuck or skin bag contains about 101 gallons, and he can fill it and empty it half-a-dozen times, whilst a water-cart containing 120 gallons is filled and emptied once. The bhistie receives five rupees a month, whilst in addition to the keep of a pony and maintenance of a water-cart, there is a driver on seven rupees and two coolies also on seven to fill the cart. Each bhistie should sprinkle about twelve thousand superficial feet of road surface, working for three hours : a water-cart will sprinkle about twice or thrice the area according to the distance of the water supply.

In many towns street-watering is carried on by voluntary contribution from the inhabitants of the streets watered, and this, where there are no public funds available, is no doubt very desirable, but it is clearly one of the duties of the local authority or municipality wherever their funds will permit.

One of the most frequent sources of pollution of the atmosphere of our towns and villages is the defilement of the waste lands and unoccupied compounds. In this country any piece of vacant land is speedily covered with rank vegetation, and it as speedily becomes the place of deposit of garbage, dead animals, filth, and nightsoil. It is resorted to for purposes of nature by all the low class inhabitants of the neighbourhood, and soon is a focus of foul odours and miasma.

Although the Mofussil Municipal Act contains ample provisions for enforcing penalties against the owners of. such lands, it is not always easy to apply them. Many of the owners are absentees, and with others the excuse is, 'other persons defile my land, how can I prevent it ?' This excuse ought not to be admitted. If property has its privileges it has also its obligations, and the first of these is that it shall not be a nuisance to the community. A man has no right to retain the ownership of property within a town unless he is able and willing to maintain it in such order as to prevent annoyance and injury to his neighbours. The inclosing of all open and unoccupied spaces within towns, so as to prevent access to them for improper purposes, should be required and enforced, and the owners after due and sufficient warning, should be mulcted in such amount of penalty as will enable the municipality to appoint and maintain sufficient watch and ward to prevent these nuisances. It would have a very salutary effect if, after due notice, the owner. of every waste piece of land, which was in such a state as to be a source of annoyance to the public, were fined in such a sum as would suffice to pay for cleansing the land and maintaining achokeydar for at least three months. the duty of such chokeydar being to warn off trespassers and to arrest any person throwing garbage or filth or resorting thereto for purposes of nature. The ordinary municipal police are seldom sufficient, numerically, to undertake such duties; but a little extra vigilance on their part would seldom be thrown away, especially in preventing the defilement of the roadsides and drains. and open spaces immediately adjacent to, and in view of, the public streets.

#### CHAPTER X.

"It is the true aim and object of the Sanitary Engineer's assist Nature in her great and simple operations."-Baldwin Latham.

"The defects of the climate of Calcutta during the latter part of the rainy seasons may, indeed, be ascribed in a great measure to the state of the drains and watercourses, and to the stagnant water remaining in the town and its vicinity."—Marguis of Wellesley.

One of the principal insanitary features of Indian towns and villages is their inefficient drainage. In many towns and most villages the drains are simply excavations in the losse soil, running generally along the roadsides, but often where they cross the district, form<sup>1</sup> ing the original demarcation of private lands, the tortuous boundaries of which they follow without any reference to the natural fall of the land or to the purpose for which drains are constructed.

Their general plan and construction are in most cases faulty in the extreme: they are more or less deep according to the caprice of their original excavators or according to the demand for earth to raise the *pagars* of the proprietors of adjoining lands; their sides have no proper slope to prevent the falling in of loose earth, their bottom no sufficient inclination to permit the water to pass through them with sufficient velocity to carry off the solid filth and prevent deposit and downward percolation. Weeds and coarse grasses grow on the bottom and sides; field-rats burrow up the banks and throw out heaps of earth; and during the rainy season, it is a common practice for the villagers to place bunds or dams of stakes, weeds, mud, and fish-traps across them to intercept the fish with which every stream of water abounds in the rains: all this tends to obstruct the flow of water in the more rural parts.

In populous quarters further and more serious obstructions occur, especially where Municipal or other local authorities are either careless or lack sufficient means to keep up the necessary establishments, and where supervision is therefore lax and insufficient. Culverts and entrance bridges are constructed with insufficient waterway and of too great length to permit of proper cleansing. Owners of huts often secure and extend their earthen foundations by driving rows of pins or stakes along the course of the drain, and projecting as far into its bed as they dare venture without fear of the sanitary or local authority. Earth is filled in at the back, and is as often as not, dug from the bed of the drain itself, at once destroying its level and leaving a hollow for water to accumulate, and sewage to stagnate in. The next process is to place over the drain a platform or bridge from four to sixteen feet in length, constructed of loose planks, auran sticks or bamboos. This may serve either as an entrance to a house or hackney carriage stable, or as a shop frontage. Sweepings, refuse, dust, horse-dung, and kitchengarbage fall through the interstices; rats honeycomb the sides of the drain underneath the platform, forming an accumulation which effectually obstructs the flow of water in the rains, while in the dry weather the addition of ablution water, rice-conjee, the washing of vegetables, fish, and domestic utensils, and in the case of stables, the urine of the ponies, or so much of it as is not absorbed by the clay-floor of the stall, help to form a hot-bed of putrid filth eternally seething under the noses of the inhabitants.

Add to all this, the drainage from pucka house kitchens, 'the' washings from privies, the decomposing dung and urine from goals or cow-byres, the use of the drain sides ' by passers-by or residents of the locality for purposes of nature, and perchance a dead dog or cat in an advanced stage of decomposition, and the condition of an ordinary uncared for cutcha drain may be imagined. In fact they are in too many instances "elongated cess-pools, the most filthy and disgusting nuisances of the town, a permanent source of effluvia detrimental to health and destructive to the life of the inhabitants."-(Calcutta Health Officer's Report 1865.) Of course things are not always so bad as above represented, nor do they always continue so.

During the rainy season, if the Conservancy Department has been moderately active in removing obstructions, the drains are swept by the heavy rainfall, and the filthy deposits either carried off or so diluted as to be comparatively inoffensive. And again, there is generally a period of annual cleansing and excavating, when the silt is dug out and either carted away, or, as too often happens, is spread over the flanks of the road to raise the surface and be desiccated by the powerful rays of a tropical sun.

But here again another evil arises,-the usual manner of cleansing simply aggravates the faulty construction of the drain. The silt is dug out by ignorant coolies, generally *dhangars*, working under the direction of a *peon* as ignorant as themselves, or of an overseer of no professional knowledge and often but little practical experience, and the depth to which the drain is excavated is regulated more by the quantity of earth required for the *cutcha* road repairs than by the requirements of the drainage. The liquid portion of the sewage which finds its way into these drains, therefore, exposed to the full heat of the torrid zone, with hardly any flow, either evaporates or soaks into the subsoil, and saturates and fouls the foundations of the dwellings of the people, leaving the solid filth to be removed in the form of a black putrescent mud.

Another common fault of drains in Bengal towns and villages is the want of any proper outfall. In many places, notably in the Suburbs of Calcutta, they lead directly into tanks or ponds by the side of the roads. The tanks have been permitted so close to the roadsides that the drains must fall into them, the road surface water and sewage flow into the hollow, until it is filled to the brim, the spill water finding its way through the continuation of the drain on the opposite side (if permitted by the levels, which is not always the case), the pollution of the tank being a secondary consideration in the eye of the owner to securing a supply of water for fish-raising.

In other cases the drains simply lead out into the open country and end in the rice fields or *jullas*, and as these remain throughout the rainy season, and for some time after, full of water, the town or village drainage is headed back and stands in the drains for several months in the year, and thus keeps up that saturation and humidity of the subsoil and foundations, so inimical to the health of the people. The evils arising from this state of things can hardly be exaggerated; they are admitted by all sanitary authorities, although, as is usual in such cases, 'doctors disagree' as to the extent to which the prevailing fevers of Bengal may be attributed to it.

Professor Max Von Pettenkofer's opinion is, that humidity of soil is a necessary factor in the etiology of fever epidemics.

Dr. David B. Smith, some while Sanitary Commissioner of Bengal, says,—" There is constant and close connexion between humidity of soil and high rates of sickness."

The Council of Hygiene of the City of New York reported, after a most carefully-conducted series of hygrometrical observations, "that any marked degree of excess of humidity in any locality was without exception found to be associated with an excessive constant sickness-rate and with all kinds of contagion and infection."

Mr. Simon, Medical Officer to the Privy Council, considers that "an undrained or damp state of soil in populous localities is dangerous to public health, and falls under the legal definition of a nuisance, for which sanitary authorities are responsible."

I have quoted enough to show that high sanitary authorities view obstructed drainage and consequent water-logging of the soil as being a distinct danger to health and life; and I will close this chapter with an extract from a very valuable and practical pamphlet submitted to Government by a well-known and greatly respected zemindar, whose natural ability was quickened by a liberal education, and whose interest in the subject was enhanced not only by his natural sympathy for his fellow-countrymen, but by the large stake he held in the country, and the large interest he had in the wellbeing of the urban and rural classes, amongst whom his tenants were numerous. I allude to the late Hon. Rajah Digamber Mitter, C.S.I.: writing of the causation of the malarial fever which had become fearfully prevalent in Lower Bengal, and especially in the Burdwan District, he says,-" The type of fever met with in the epidemic districts is solely due to a something in the soil, and the condition most favorable to the development of that something is excessive or abnormal humidity of the subsoil. The cause which operates most powerfully to produce that condition is impeded drainage: it is the inordinate humidity of the subsoil of towns and villages, and not of the paddy-fields and jullas, which contributes to the outbreak of the fever with epidemic intensity. The fact that the natural drainage of a Bengal town cannot be interfered with, with impunity, which of all others should have forced itself generally into notice, is yet just the one least generally known or recognised, and it is to this ignorance or indifference that is to be attributed the ruin of many once-flourishing cities and towns both in earlier and later times."

We may thus sum up the insanitary characteristics of Indian towns and villages where the state of the drainage is as above described. Excessive humidity of the atmosphere, stagnant waters, obstructed flow of drainage, water-logged subsoil, damp foundations, luxuriant vegetation, impeded circulation of air, decomposing animal and vegetable matter, and putrid exhalations.

#### CHAPTER XI.

"Before an Engineer attempts to sewer any town or district, he should enquire how nature has provided for passing off the rainfall and the surplus surface water, and he should interfere with that as little as possible."—*Rawlinson*.

Where funds are available, remedies are easily found and applied; but impecuniosity, if not absolute insolvency, is the normal state of most of the *mofussil* municipalities in Bengal, and it is not the object of this work to treat of elaborate and complete schemes involving large outlay and great engineering skill; but of such improvements as are within reach of the ordinary municipal purse, and such as can be carried out, if need be, under the supervision of persons possessing but a moderate amount of engineering knowledge; but the first principle to be observed, is that laid down by Mr. Rawlinson, C.B., C.E., M.I.C.E., and quoted above. Where the drainage, therefore, is such as I have described in the last chapter, the following remedial measures must be adopted as far as practicable.

Where possible, a complete series of levels of the different drains should be taken. This should be accomplished without much difficulty or expense, flooded as the country now is with the graduates of our State colleges.

This done, permanent masonry matams or bench-level marks should be built at intervals of every 200 or 250 feet, in the bed of every drain; and where drains pass along the basements of buildings, under bridges, and

### Levelling.

other permanent masonry structures, bench-marks may be cut or otherwise indelibly marked on their surface, for the guidance of the conservancy staff. It will then be comparatively easy to maintain the level, when the drains are being excavated and silted. A convenient form of level is of importance in making or excavating drains, in fact where there is little fall, the use of a reliable instrument is quite requisite to grade the bottom of the drain at a true inclination, so that the sewage water may flow steadily. The ground surface is often so deceptive that levelling by the eye and random guessings should never be trusted to. The figure (A) as under, represents a



Fig. A.

simple, cheap, but efficient drain-level that any carpenter can make in wood in an hour's time; A A are pieces of wood one inch thick, eight feet long, four inches wide at the lower ends and two inches wide at the top; B is a graduated cross-bar screwed to A A; P consists of a plummet and line. Before marking the graduated scale on B, let the level be turned halfway round, if the plumb-line indicates the same point or mark, the level is practically correct. The pieces should be planed smooth, painted, and the joints screwed together. Templates are useful for forming the banks or slopes: they + can easily be constructed as shown in figure (B) of any



Fig. B.

straight wood, three inches wide, and one inch thick.

Unless the bottom of a ditch or drain is made with an uniform gradient, the earth being soft and readily washed out in some places, and more compact in others, the bottom of the channel would be liable to be gullied where the water runs most rapidly.

No excavation or silting out must be permitted below the level of the bench-marks.

Where a long course of unscientific silting out has lowered the bed of a drain beyond the proper level, it should be raised with sound earth, clay or building rubbish, well rammed and beaten down so as to form a smooth impervious bed. As a general rule, it will be found that the remedy required consists in raising, instead of deepening, the beds of all old cutcha drains.

In raising the bed-level of drains, the work should always be commenced at the highest point of the drainage. Whereas in excavating or silting, the coolies should invariably start from the point nearest the outfall, and work up the drain. Wide mischief is caused by careless, aimless, and irregular excavation of drains' at their upper portions, thus often necessitating an undue deepening of

## 108 Retaining Walls and Drain Bridges.

the outfall end if the water is to be allowed to flow off. An ignorant overseer or road *jemadar* thinks he has done a praiseworthy work if he has carefully cut out the bottom and sides of the *cutcha* branch drains in his immediate section, leaving a dry clean bottom and well-trimmed slopes, without giving a thought to the consequences of lowering the bed of the drain at that point, possibly lower than the outfall itself.

All culverts, bridges, and covered ways should be constructed of the full width of the waterway of the drain, and with masonry floors or inverts placed a couple of inches lower than the bed of the drain to permit of proper silting without disturbing the level. Retaining walls and other structures placed alongside the drains must have their foundations sufficiently deep not to be disturbed or endangered by ordinary excavation, or silting. All bench-marks, inverts, floors, arches, and other masonry structures should be built of sound, hard, wellsoaked bricks, laid with first class hydraulic lime mortar and the joints raked and pointed with cement, composed of one part fresh Portland coment and two parts clean sharp river sand. What is called *cutcha-pucka* masonry should never be tolerated: it has no stability, and the bricks being porous, and the mortar mud, or very inferior soorkee and lime, the open soft joints soak in the sewage, become intensely foul, and more difficult to cleanse than a simple clay bottom or bank.

Rough piling of the drain sides with wooden or bamboo pins, and bamboo, stick, or rough plank platforms, should never be allowed. The extension of shop frontages into the street is a fraud upon the public. Where bridges are required for access to shops or stables, or carriage-ways to private houses, they may be constructed with a platform of well-fitted planks, removeable at pleasure; placed over masonry side walls, built with a sufficient batter, and brick-on-edge invert, set on concrete as shown in the following sketch. Such structures are



P. Plank top bolted to. T. Cross limbers. L. Level of drain bed. I. Invert. C. Concrete foundation.

more expensive at the outset, but they are necessary improvements, and not more costly in the long run when renewal, fines, penalties, and blackmail are taken into consideration in addition to first cost. Native houseowners are very fond of constructing raised masonry platforms covering in the drains along the entire frontage of their houses. These form lounges facing the street, and serve to conceal what are often very filthy drains.

Not unfrequently the ends of these platforms are enclosed by screenwalls and used as urinals. I have even seen a privy erected over the drain in such a situation. Such constructions should never be permitted: they not only form an obstruction to the drainage, are difficult to clean through, unless of large size, and provided with man-holes at short intervals, but they tend to reduce the width of the streets and are unwarrantable encroachments on public land, being one of the means by which house frontages are gradually pushed out into the street—first comes the platform, then perhaps a temporary sunshade is placed over it, and if that escapes notice, it is replaced at some future time by a more permanent structure, till after the lapse of a few years, the fact of the original encroachment has been forgotten and the wily Hindu has "enlarged the borders of his tent" and acquired a strip of valuable frontage at no cost to himself and to the detriment of public rights. The Municipal or other local authorities who knowingly permit such encroachments, clearly fail in their duty as trustees for the public.

In forming or improving drains three questions have to be considered: the amount of velocity of the sewage flow required to carry off impurities; the capacity required to carry off the maximum quantity of water falling into the drain in a definite period; and the scouring action on the bottom and sides of the chanuel.

The velocity depends on the hydraulic mean depth of the stream and the inclination of its bed. The hydraulic mean depth is ascertained by dividing the cross sectional area of the stream by the width of its cross section measured along its bed. Or in other words —

"By dividing the sectional area of the channel by the wetted perimeter, or the *contour* of the wetted channel, we get what is called 'the mean hydraulic depth,' or often, 'the mean radius."—Baldwin Latham.

Then the inclination remaining the same, the greater the mean depth, the greater will be its velocity.

The sewage flow in cutcha drains is, however, great-

ly influenced by the irregularities and roughnesses of the channel, the friction being thereby greatly increased, and the extent of surface with which it comes in contact, proportionately retards its velocity. Drains should not be made of a greater width and depth than is actually required to carry off the highest average quantity of water passing into them.

In considering the amount of fall or inclination to be given to the bed of a drain, it would seem at first sight as if too great an inclination could not be given in order to make it discharge its contents in the shortest possible time, and to wash out all solid filth which with a slow current has a tendency to deposit; but here the scouring action must be taken into consideration, and its effect upon the bottom and sides of the drain must not be overlooked.

In Neville's Hydraulic Tables, &c., it is stated, that "the mean velocity of a stream must not be too quick, and should be so determined as to suit the tenacity and resistance of the channel, otherwise the bed and banks will change continually, unless artificially protected. It should not exceed 25 feet per minute in soft alluvial deposits, and 40 feet per minute in clayey beds. It is true that Neville is here speaking of rivers, the conditions of which are widely different from drains."

A surface velocity of two feet per second will, as a rule, be found sufficient for practical purposes. The surface velocity of a stream may be easily ascertained by measuring a given length along the bank between two fixed points, theu throwing a cork or piece of light wood into the stream, the time taken for it to pass from point to point as checked by the second hand of an ordinary watch will give the surface velocity. Summed up shortly, therefore, the conditions to be observed are, that the drain shall be able to carry off with sufficient velocity the maximum quantity of water or sewage likely to pass into it, but that the velocity shall not be so great as to endanger the bottom or sides.

The efficiency of town drainage depends in a great degree upon its outfall. This may be either into a river, canal, or tidal creek, or into the *jullas* and rice-fields, and in the latter case it follows the natural fall of the country.

Where the drainage falls into a running stream, it is usually easily managed and uninterrupted, except by exceptional causes, such as unusually high floods. When into a canal, tidal creek, or river, it is necessarily intermittent, and the influx of tide water has to be provided against; but where its outfall is into the rice-fields or *jullas*, the storm-water and sewage is often headed back, and the drains remain brimful during the rainy season, the spill water only passing off. This lasts till the water-level sinks by the drawing off of the water from the fields and by evaporation and subsoil percolation.

As the water in the rice-fields is a necessity of the cultivation, we cannot (even were it practicable) propose to drain off these lands; the only way, therefore, to meet the difficulty is to carry the main drainage channel between embankments through the fields and *jullas* till we reach some natural watercourse, at a sufficiently low level, to permit of the water of the drains falling into it. If the watercourse be tidal, a sluice or tidevalve must be provided. If no such natural facilities present themselves, the water must be lifted by steam or wind-power as in the Fen Counties of England and the Lowlands of Holland. It has often been a matter of surprise to me that such a comparatively inexpensive method of pumping water for drainage or irrigation purposes has not been introduced into this country. In no part of India have I ever seen a wind-mill. In the present day steam-power has almost entirely superseded windpower in large drainage works; but I can well recollect when wind-engines were in universal use in the Fen Counties. Littleport Fen, with which I was familiar as a youth, having an area of 28,000 acress drained by wind-engines, now superseded by two steam engines of 30 and 40-horsepower. The following account of the great Bedford level drainage will illustrate what great results may be attained by utilising natural forces:--

The Bedford level is a vast tract of about 400,000 acres of lowland, extending into the counties of Northamptonshire, Huntingdonshire, Cambridgeshire, Lincolnshire, Norfolk, and Suffolk. It was formerly dry land, but, from natural convulsions and other causes, it gradually became a vast morass. As early as 1436, the idea of draining these fens engaged attention. Large sums were expended in attempts to embank and reclaim them, but all of which ended in failure, until in 1634, William, Earl of Bedford, undertook to drain them on the understanding that 95,000 acres of the reclaimed land were to become his. For three years he prosecuted his labours, expending in the attempt £100,000, but again failure was the result. In 1649, the Earl, nothing daunted, again commenced operations, and after outlaying £300,000 in draining, embanking, and protecting the land, met this time with success. In 1664 a corporate body was formed for the management of the reclaimed lands,

which is still in existence. The Fen lands are intersected by numerous channels, some of them being navigable for over twenty miles. In draining the marsh, the water was raised by wind-engines. In some cases these engines turn a perpetual screw, fitting into a semicircular trough, inclined at an angle of about 30°, the lower part dipping into the water below, and discharging by its revolution the water into the higher level. By this form of engine the friction of pumps and wearing out of machinery are reduced to a minimum, and the mills require little attendance, but work night and day as the wind blows. I have heard high praise of this form of engine from natives of Schleswig Holstein, where it is in constant use, and it was used with great effect in emptying the dry docks at Shanghai. The Dutch, who carry on this system of drainage extensively in their lowlands, employ scoop-wheels worked by wind-engines; and where the lift of water is not more than seven feet, they are very effective.

Where the drainage falls into a tidal stream or creek, and the point of outfall is below highwater marks, the action becomes intermittent,—that is to say, the drainage water can only pass into the stream at those periods of the ebb and flood when the water-level of the stream is below the level of the sill of the outfall, or at least sufficiently low to be overcome by the head of water in the drain, and sluice-gates or tide valves are necessary to prevent the tide water from entering the drain. The sluices will open to discharge drainage when the ebb-tide has fallen sufficiently to reduce the outside pressure below that exerted by the water in the drain, and will remain open until the in-coming flood has again risen to the same point, when they will be closed by the pressure of the tide. Where the water in the drain is much higher than the flood-level outside, a considerable portion may be discharged through a valve in the upper part of the sluice or by side valves in the masonry; and as soon as the water outside has fallen so far that the head of water inside can overcome the friction of the hinge and the outside pressure, it will begin to discharge, although the tide may still be above the level of the sill or floor.

No matter of what construction, or however well-constructed and well fitted sluice-gates may be, there is always some weak point about them, some liability to accident or derangement, which renders them a source of constant anxiety and necessitaies constant attention. If the material be iron, it corrodes; if wood, it swells or shrinks, and rots under the influence of alternate wetting and drying.

If self-acting, they get jammed and choked with floating rubbish, grass, trees, &c. If worked by hand, they are liable to neglect by watchers, who forget to open or close them at proper times.

Where drainage outfalls pass through or communicate with rice-fields, they require, whether self-acting or not, careful watching, as in dry seasons the raiyats will force them open to admit the river water to irrigate their fields. I have in my mind, whilst writing this, two large and important so-called self-acting sluice gates communicating with the river Hooghly, which are a source of constant trouble, and which have never been anything else during my many years' acquaintance with them.

One is an upright gate or tide-valve hung by hinges at the top, and abutting perpendicularly against masonry

### Causes of Obstruction.

walls, as shown in figure. It is constructed of wood, covered with sheathing metal, and with long strap hinges. It is constantly obstructed in the manner depicted, and is thus effectually prevented from closing when the tide rises, which consequently floods the drain and heads back the sewage water of the town.



The main faults of this sluice are its unwieldiness, and from its being hung perpendicularly, it is not properly self-closing until forced back by the tide water. A lighter gate with slightly sloping abutments would be better, as it would shut close with its own weight, be kept close by the pressure of the water outside, and would yield easier to the pressure of the inside water as the tide falls.

With proper supervision, the draw-up sluice or penstock worked by hand, is the better form. It can be worked by one man, and can always be constructed to fit better and be more water-tight than any self-acting sluice; and as there must necessarily be a man always in charge of it, it is less liable to be obstructed by drift.

Where funds permit, all surface drains within towns and along the streets should be made pucka There are several forms of surface drains, the neatest and most efficient for drains of small width, being made of artificial stone moulded to the required section. Other useful forms are tile and brick-on-edge drains. Bricks for drain floors should never be laid flat, and all the joints should be raked out and cemented. Where streets and lanes within towns are very narrow, so as not to permit of drains being excavated or constructed on both sides, the free passage of the surface water may be provided for in the manner shown in the section in the margins, the surface of the lane being sloped towards the side, a half drain is formed by laying brick on edge over the soling brick, which should be lifted and replaced over nine inches of concrete as shown in the margin, the basement of the house walls being plastered with Portland cement to a height of one



foot. The advantage of this form is, that, while it provides free passage of water, it does not reduce the width of the roadway, as carriage wheels can pass over the drain without injury to either.

All covered drains and under-ground sewers are a mistake, unless there is a constant and sufficient flow of water to flush them.

#### CHAPTER XII.

"Before creeting statues, building museums, and buying expensive pictures, towns should be relieved of bad odours and fermenting putrescence. Good privies are far higher signs of civilization than grand palaces and museums of art."—Stramm.

There is no branch of practical sanitation more important, or which has given rise of late years to so much discussion amongst sanitarians and municipal authorities, as that which deals with the removal of excreta from dwellings and towns, and with its ultimate destination, whether as regards its economic utilization or simply as regards its disposal in such a manner as to secure it from being any longer a nuisance or a danger to the health of the people; and the subject is one which, far from having arrived at a satisfactory settlement, is daily forcing itself more and more on the attention of all connected with, or interested in, the health of towns. the preservation of watercourses from pollution, and the increase of the reproductive powers of the soil. In thinly populated rural tracts, the subject is of little importance, for that, first of all deodorizers, the earth, receives and assimilates the thinly scattered excretal deposits; and owing to the desiccating power of the sun,

the rapid diffusion of effluvia through the air, and the absorption of the liquid and organic matter by the earth, there is little nuisance or danger resulting. " It is only when men collect in communities that the disposal of excreta becomes a matter literally of life and death, and before it can be settled, the utmost skill and energy of a people may be taxed."-Parkes. So far as theory is concerned, we may, without hesitation, accept the views propounded by the advocates of utilization of all excremental matters in enriching and recuperating exhausted soils, and thereby multiplying their productive powers; for the agricultural value of sewage constituents has been abundantly proved by repeated trials and practical operations extended over a series of years and in various countries and climates, from China and Japan to the farms of the North American Union. But putting aside general sewage systems,-that is to say, removal of town sewage by water carriage through a complete system of underground sewers and drains,-there is no known system of disposing of the fæcal matter of large towns which can yet be called an economical or commercial success. Professor Corfield justly says, that "No scheme which does not remove all refuse matter in as inoffensive a manner as possible, and utilize it so as to 'make it pay,' can be accepted as anything like a final solution of the question that we have to study, nor can such a scheme be recommended to towns as a feasible plan for the removal of their difficulties."

The Executive Committee of the Society of Arts, at a conference held in 1876 on the health and sowage of towns, came to the following conclusions :----" That with regard to the various dry systems, where collection at short intervals is properly carried out, the result appears to be satisfactory, but no profitable application of any one of them appears as yet to have been accomplished;" and further, that, "as a rule, no profit can be derived from sewage utilization."

Putting aside then, for the present, the economical and commercial view of the question, we will revert to what is, or should be, the primary object of the local sanitary authority,--viz., to secure the removal regularly, rapidly, and thoroughly, of all excreta from dwellings and public latrines; the absolute necessity of our doing so will not be disputed by any reasonable being. The evil effects of allowing fæcal deposits to remain and decompose within, or adjacent to, dwellings, has already been touched upon in the earlier chapters of this book, and it is, therefore, unnecessary to do more than allude to them here ; but we cannot too often repeat that this is a duty which must be carried out at any cost. "Safety." says Dr. Parkes, "is the first thing to be sought, profit must come afterwards."

"For health's sake, without consideration of commercial profit, sewage and excreta must be got rid of at any cost."-- Confer., Society of Arts.

I think few people will be found to dispute this doctrine, and no argument is necessary to satisfy any person that accumulations of filth cannot be left in human dwellings without danger to life and health, and violence to all sense of decency and cleanliness.

Some persons may argue that such accumulations do remain, and have remained, for years in well-privies without causing any visible harm; that there are in many native dwelling-houses Sundeshes, which have existed for many years without the inhabitants of those houses suffering from their evil effects. I admit the first part of the proposition, but I have never found proof of the latter; and I beg leave to doubt it as opposed to evidence. science, and common sense. I admit that these abominations are by no means peculiar to this country, that, in England, Scotland, the Continental Cities and in New York, there are privies and cesspools to the full as bad or even worse than those in existence here; but the evil of them is fully recognized, and if they are evils and dangers in temperate climates, what must they be in the warm, moist, tropical atmosphere of Lower Bengal. There is perhaps no subject on which the middle class residents of our native towns are more averse to any change than in the regulation and improvement of their privy accommodation, and herein they lack not only one of the most important comforts and decencies of life, but many of them do not even know that they lack it.

With bodies that are susceptible to the poisonous influences of putrefying filth, with their health more or less constantly subject to these influences, undeterred by the warning given by the loss of relatives who have fallen victims to malarious or filth diseases, they live on, indifferent to, if not ignorant of, the dangers and discomforts that surround them. They are busy in accumulating the means for more luxury, while they remain blind to improvements that, costing but little, would prolong their lives, secure exemption from disease, and make their homes much more fit abodes for an intelligent and prosperous people.

I feel sure that in no other direction could compulsory measures be applied with greater justice and pre-

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priety than in compelling the removal of human excreta from amongst the dwellings of the people, and if then we recognise the general principle, we must further recognise the principle that such removal must be effected, irrespective of cost, and that that cost, whatever it be, must be borne by the community. We have, therefore, to consider how such removal is to be effected in as efficient, while in as economical, a manner as possible, and in so doing we may at once put out of the question, as beyond the scope of most small mofussil towns and villages the system of water-carriage.

That system involves an enormous expenditure, and requires the existence of three main features,—viz, a complete system of underground sewers, a sufficient and efficient watersupply, and a convenient and unobjectionable outfall for the contents of the sewers. Where all these conditions do not exist, and they form a Sanitary Trinity, neither of which can work without the other, the hand-system, or removal in substance, must be adopted, and it is with the hand-system in its various forms that I purpose to deal.

The following are the most usual methods of removal by hand in use either in England or this country :---

The dry-earth, or Moule's system,

The bucket, or Hallalcore system.

The pail-system, of which there are several varieties, viz., 1st, pails or tubs in which a certain amount of a deodorant or disinfectant is used, as in Rochdale, Nottingham, Leeds, &c.; 2nd, pails used without any preparation, as in Glasgow, Berlin, Leipsic; 3rd, pails into which coal ashes are sifted over the excrement (Manchester, &c.); 4th, pails into which ashes and general house refuse are thrown, as in Edinburgh; and 5th, pails lined with an absorbent material (Système Goux), as in Halifax, Salford, and some continental cities.

Of all these systems the one which has, rightly or wrongly, had the greatest number of advocates, is the dryearth, or *Moule's system*, and it is perhaps none the less creditable to its reverend adaptor, in that, though certainly in regard to its essential principle not his own invention, he may claim the credit of practically proving the sanitary wisdom of the great Hebrew lawgiver, who laid down this law to the children of Israel.

"And thou shalt have a place also without the camp, whither thou shalt go forth abroad; and thou shalt have a paddle upon thy weapon, and it shall be, when thou wilt ease thyself abroad, thou shalt dig therewithand shalt turn back and cover that which cometh from thee." It is hardly necessary to say that the first principle of this system is that dry-earth is the natural deodorizer of excremental matter. A given quantity of dry earth destroying all ill-odour, and entirely preventing the escape of noxious vapours. It is claimed for this process that the addition of from one and-a-half to two and-a-half pounds of dry earth to each stool is sufficient to render it inoffensive; that a certain disintegration of the fæcal matters, and combination between the earth and the organic matter contained in the excrement takes place; and that, after a short time, everything offensive disappears. That this system possesses all the advantages which its advocates claim for it there can be no doubt, and for jails, hospitals, military barracks, or similar institutions, where the number of persons is comparatively limited, labor abundant, and scientific supervision always available, it is in every way admirable and desirable; but for a large town I have no hesitation in saying, and in this I am supported by good authorities, that it is simply impracticable.

For every pound weight of excreta to be carried out of the town, three to four times the amount of earth must be carried in, to be carried out again.

Then we have to consider the difficulties of procuring. drying, storing, and distributing the earth. We have the - well-considered testimony of the River Pollution Commissioners, that " they have no hesitation in pronouncing the dry-earth system, however suitable for institutions, villages, and camps, where personal or official regulation can be enforced, entirely unfitted to the circumstances of large towns." It will be obvious also to every one who thinks over the subject, that the system, depending as it does, on the dryness of the earth to be used, could never be introduced with success in any town subject to from four to five months' constant and heavy periodical rains. We may, therefore, dismiss this system as impracticable for general municipal purposes, in spite of the constant, though somewhat inconsequential, advocacy of its admirers. The author was the first to introduce (in 1874) on this side of India what is called the Bombay Hallalcore system in a somewhat improved form, and this was subsequently followed by its adoption by the Calcutta Municipality and other Corporations. The system, may shortly be explained as the employment by the municipal or local authority of a regularly organized corps of scavengers or nightmen, and the division of the houses in the town into blocks or circles. The houses are allotted to the nightmen, in the ratio of about thirty

houses per man; these visit each house daily (in the early morning), and remove the contents of the privypans in a closed wooden or zinc bucket (in Bombay at the time of my visit open baskets were in use!) to central depôts, where the filth is either collected in airtight iron-carts to be removed beyond the town, or is discharged directly into basins connected with the sewerage, where such exists. The system, when well worked and properly superintended, is one of the best hitherto tried in this country; its primary feature being the regular daily removal of the filth.

The Sanitary Commissioner for Bengal, after inspecting its working in the suburbs of Calcutta, recently reported upon it in the following terms: "On the whole the system is an admirable one, when well looked after, and worthy of imitation in other municipalities." But although the working has been very successful, and has effected undoubted improvement in the sanitary condition of those towns where it has been introduced, it has many and serious drawbacks and failings, nearly all of which might be obviated by the adoption of one of the pail-systems before alluded to. The chief objections to it are, that it is an expensive system requiring a very large staff.

It is from its great extent and the number of men employed difficult to supervise and control; no efficient check can be employed over the nightmen without the entertainment of an enormous inspecting staff, and, therefore, neglect to remove the filth is a common occurrence.\*

This difficulty may be obviated by giving the work to a contractor, an arrangement recently adopted by the Calcutta Suburban

# 126 Nursance of Existing System.

It is a filthy system in practice, and gives rise to domestic and public nuisance of no slight character. The system of working is as follows :-- The scavenger goes from house to house with a bucket and broom; into the first, by the aid of the latter, he empties the contents of the privy-pan, generally a wide, shallow earthenware pan, but often he leaves the bucket open by the roadside, while he goes up a narrow alley to the privy and brings out the filth in an earthen pot to be emptied into his bucket in the street. Can any greater nuisance to the early pedestrian be conceived ? The nuisance within the privy is even greater, the porous earthenware vessel roughly emptied of its contents, presents an increased foul surface to give forth effluvia.

Professor Corfield notices this very point with regard to similar systems at home. He says: "The removal of the matter is at all times a filthy operation, and the iron-pans when empty smell even worse than when full, as there is then a greater surface exposed." Then it is almost impossible to check the practice of the scavengers placing their tubs, full or empty, on the roadsides while they enter the houses, or go to smoke or rest, and being, like all persons of that class, careless in the extreme, the lids are continually lost and the contents exposed. The sights and smells, which those who indulge in early morning rides and walks about an Indian town are exposed to, may be better imagined than described.

The advantages of a weekly pail-system are obvious; the first factor is the pail or tub. This may be either of metal or of wood; in shape it should be round and straight, but slightly wider at the bottom than at the mouth to insure strength; of sufficient capacity to contain the fæcal matter of a house-privy for a certain given time; and it must be fitted with handles for removal and a tight-fitting lid. A pail, eighteen inches high by fifteen inches diameter, will contain the dejecta of sixty persons for one day, or six persons for ten days' use. The pail is placed directly beneath the privy seat, and left there undisturbed for the number of days fixed for the rotation. When removed, it is covered with the lid, carried to a covered cart, and a clean pail left in its stead. By this means there is no disturbance of the filth, and consequently less chance of disengagement of gases and effluvia.

Another advantage is, that the tubs being taken direct to the place of discharge, a thorough check is practicable, as the person in charge will at once detect and report any defaulting scavengers who fail to bring their due tale of tubs. The following information regarding the working of the absorbent pail system (Système Goux) is taken from details kindly supplied me by the Chairman of the Sanitary Committee of Halifax, where the Système Goux has been in use for ten years. I. would not, however, presume to offer my readers simple extracts from the records of other towns, had I not personally and practically proved by experiment that the system is workable in this country; but after fairly testing the principle I have uo hesitation in pronouncing it to be in every way satisfactory and practicable, easy of management, economical in working, andwhat is an element not to be overlooked by those who have the management and control of that somewhat difficult and obstinate class, the Helas and Haris (the nightmen of Bengal)-in no way opposed to their prejudices :---

"In reply to your inquiry of the 24th March respecting the pail-system as adopted here, I have pleasure in sending by this post the Journal of the Society of Arts for June, 1877, wherein you will find a report by me as to the working of the Goux system. Since that time we have continued to supplement the old. and detestable privies and middens with these, and every one is satisfied that we have got the best method yet introduced for the removal of excreta and house refuse. The present cost per closet per annum is about 15s., and we empty them once every eight or ten days. I may say that a bottomless can or shell is first put into the closet tub with a space left of about three inches between the can and tub : this space is filled with absorbent material : many things will answer for the purpose of packing or lining the tubs, Here we get a good quantity of woollen and cotton dust and refuse from the mills, which is of itself a good manure. We also use dry street sweepings, screened ashes, &c., but the latter requires some fibrous substance mixing with it to make it stand round the tub after the can or shell is taken away, which is done when the closet tub is left at the closet; the cans are then put under the van. and the tub inside the van and driven to our depôt. When the full tub is taken out of the closet, a handful of the packing is taken out of the new tub and sprinkled on the full one, and the public can then see nothing bat what appears a tubful of mill refuse or other material.

"Of course, in Calcutta you will have material suitable for lining the tubs, but I cannot suggest what would be best. We get a material, if we can, that makes a good manure independent of the excreta, otherwise we might get packing of less cost and so reduce the cost of collection.

"I think the members representing this Borough in Parliament will bear me out in saying there is no method yet introduced to supersede ours.

"At the commencement we found some difficulty in having to number each closet door for the guidance of the men and in finding customers for the manure; but now we have it in such working order that there is little or no trouble, and very few complaints, and only those where the collectors are now and then negligent. The tubs we use here we make from petroleum or paraffin oil barrels or fruit barrels; the former are more serviceable and cost less; they are cut in two for closet tubs.

"I must confess that, in my opinion, and in the opinion of the Sanitary Committee over which I have the honor to preside, the Goux principle is the most satisfactory we have yet seen, and we have seen many, and have given the subject some consideration during the last seven years. The great advantage over others is, that the packing which is placed in each tub will absorb from six to eight quarts of liquid, and the charcoal or soot which is in the packing prevents decomposition, and deodorizes the excrement and urine as the tub becomes full; and also to a great extent fixes the ammonia, and so makes a good fertilizing manure. We have tried the plan without lining, and found the disinfectant, which was put into the bottom, was soon so much diluted that, to a great extent, it lost its effect as a deodorizer and disinfectant; and when the receptacle was used partly full, there was a disagreeable effluvia on account of its being nearly in a liquid state, whereas the liquid or urine is gradually absorbed and deodorized by the packing of the Goux tub. Another advantage of the system is, that when the sanitary inspector informs the manager of the Goux department of any case of fever, the closet is cleared every two or three days; and, from an analysis which has been made, it was found that there had been fewer cases of fever in the wards or districts where the tubs were in use. I am satisfied that constant removal is a step in the right direction, and am glad the question is receiving more attention than it has hitherto done, for we ought no longer to allow fiecal matter to be deposited within a few feet of the very atmosphere we breathe, and allow it, together with all kinds of animal and vegetable matter. to decompose for twelve months, and in many cases the liquid matter to percolate under our house floors.

"There were more cases of fever where the old privy system prevailed than where the Goux closets were in use.

At a meeting of the Conference of the Society of Arts, the system in force in Halifax was very fully discussed, and the following interesting and valuable testimony was given in favor of the Système Goux :--

" Mr. Denham (Southsea) asked whether the process was very offensive one to look at ?

"Mr. Pollard thought not so offensive as the system without the lining, or the old privy system.

"Dr. Syson said he had had experience of the Goux system in its carliest introduction, and had been asked to give his opinion upon its merits. He saw it first about 1869, when he was connected with Salford, and they were making sanitary experiments with a view to abolish the old middens. The simplicity and cleanliness of this system then struck him. He called the attention of the Health Committee to it, and a somewhat extensive trial was made. During the time it was on trial they had an outbreak of smallpox, but in the district where it was in use, the lowest in the town, not a single case occurred. It had been said that it was abandoned in Salford as a failure, but this was an utter mistake. It was not given up because it failed, for they had numerous deputations from various Health Committees to inspect it, and all gave their opinion unanimously in its favour. He believed the real reason it was not adopted generally was, that the scavenging was not in the hands of the Health Committee, and that the Scavenging Committee were, as often happened, too much wedded to old customs. It might be said that he was an officer of health, and that officers of health might not be quite unbiased, but you could not persuade numerous deputations consisting of town councillors and aldermen in that way; and it was on record in the minutes of their meetings repeatedly, that they thought this system a great improvement on the old system. He was not an opponent of water-closets, and for a single house no doubt the earth-closet is preferable, but for towns or villages where water-closets could not be well introduced, this system would be much preferable.

"Dr. Haviland, being medical officer of health to the Northamptonshire combination, which included not only that county, but also portions of Leicestershire and Bucks, found, some four years ago, when he first entered on his duties, that the sewage disposal was the great difficulty he had to contend with, and, practically, in the 365 villages and towns under his charge, the watercarriage system was a failure. On setting to work to see what could be done to meet the difficulty, he found that the first thing to do was to see that a proper system of scavenging was carried out. Next year he examined the different modes of sewage disposal which had been proposed by different companies, and carried into execution throughout the country; and, after finding failure here and failure there, he was much struck with the success of the dry mode adopted at Aldershot. He thereupon went into it more thoroughly, and promised to lay a report before the sanitary authority; and for this purpose he went again to Aldershot, and twice to Halifax. In order to see the real effect upon the public health of this system, he determined to investigate the whole matter for a great number of years, in order to show the geographical distribution of disease. He first required to satisfy himself that the health of Halifax had really improved since the adoption of the system under investigation. He found that, in 1870 to 1872, before the practical working of the Goux system had been adopted. the mortality from all causes was considerably greater in all the different districts than it was later. He had very carefully worked out these figures himself for every case of death for the last ten or tifteen years, and had eliminated all doubtful cases. To show the Northamptonshire combination of sanitary authorities his belief in the efficacy of the Goux system, he undertook this laborious task, and also to satisfy his own mind, because without doing so he could not recommend such

a large area to adopt any system. Since then he had been pleased to see the result of this dry system, and was still recommending it. Only yesterday, in Leicestershire, where he was sent for suddenly in order to meet the defects of the sewage system in a village, he found the only thing he could do to avert an impending outbreak of typhoid fever was to send at once for a number of these tubs, to replace the system which was really producing the fever, and until he saw a botter plan he should continue to recommend this system. He had no interest either in this company or any other, but he simply wanted to see carried out a better system of periodical scavenging, and to seo the sewage not taken to the soil before it had time to become so matured as to be of any material benefit to the land.

"Dr. Haviland replied in the affirmative to another question, whether he attributed any special virtue to the Goux principle beyond its being a dry system of removal. He said, what he had found in practice was this, that the principle of the dry system was good, but the mode in which it was carried out was sometimes offensive. Moule's earth-closets were very excellent in principle, but he found in practice their having complicated machinery rendered them useless in villages. Wherever there was anything like complication, there was sure to be failure. The simpler the article you provided the better.

"The Chairman asked if he considered the particular kind of lining used to be advantageous?

"Dr. Haviland said, almost any refuse sufficiently absorbent would answer the purpose. At Northampton, and in villages near, they were going to use tan, and in other places stable litter would do. In the huts which were run up for the accommodation of the workmen engaged on railway works in his district, he recomménded them, as horse-power was used to a great extent to line the Goux tubs with stable litter. In Halifax shoddy was used; but anything which would absorb well and form a casing would answer the purpose.

" Mr. Moore said, that some twelve months ago he had to advise the authorities of a town of about 2.000 inhabitants what they should do with their drainage, there being much illness from defective sanitary arrangements, and the Local Government Board compelled them to do something, He came to the conclusion that a dry system of some kind was better adapted to their circumstances than a drainage system, and it was also a known fact that the germs of typhoid fever existed in the discharge from the bowels, and that if you could keep these out of the sewers you would eliminate that factor of disease which was most active. He did not oppose the water-carriage system entirely, because it was working very well in large towns, specially in London, and though it occasionally gave rise to evils, it did not do so . to any great extent, and those who had already provided sewers should not attempt to abolish them, but to render them perfect. Where, however, sewers did not exist. it was a different matter. His first idea was that earthclosets would be best, and in many places they acted admirably; but never, he believed, in a place of 2,000 inhabitants would it be possible, especially in a wet season, to get enough dry earth to work them. Finally, he recommended the use of tubs, as employed at Roch-