

CITY PHYSICIAN'S REPORT.

To the City Council:

So far as I have been able to learn, our city has for the past year suffered as little from disease as at any time since it was incorporated. There has been no severe form of epidemic, or contagious influence, afflicting any particular section, and our death-rate compares favorably with other places having an equal population.

The rate of mortality, as shown to be normal by registrars of vital statistics in this country, is 17 in 1,000, while in Concord, estimating our population to be 14,000, it has been $14\frac{1}{2}$ in 1,000, or 1 in 65. The greatest number of deaths occurred during the month of August, and the smallest in November. The largest number in any ward was in Ward 4 (61); the least in Ward 2, which was only 8. This is about the usual ratio in proportion to population.

Among those requiring assistance of the Overseer of the Poor, I think there have been quite as few cases of sickness as in years past; and the health of the inmates of the almshouse has been remarkably good, considering the broken-down mental and physical condition of many of those remaining in the institution.

This alone is *prima facie* evidence of the good care and treatment they receive at the hands of the superintendent and his wife.

The distance of the almshouse from the precinct renders

it an inconvenient place to take persons accidentally injured, or those suddenly taken ill, having no place to call a home.

The Overseer of the Poor should have a room or rooms at his disposal, near our business centre, to which such cases can be taken and temporarily provided for, until some better arrangement can be made, or their friends notified of their misfortunes.

It is generally conceded that the city must very soon have a building erected for the use of the police department; and I would respectfully submit to you, that, in considering a plan to meet the requirements of this department, it would be well to take this matter into consideration, and provide suitable rooms, properly furnished, for this class of persons, within the same building.

As now provided, there is no place to take an injured person, having neither money nor friends, except to the station-house or lock-up; and any one who has ever inspected this building will admit, without argument, that it was never intended for a hospital.

I think the amount paid annually to boarding-houses and hotels for this class of persons would do considerable towards fitting up rooms where they could be made comfortable at a small expense; and, as accidents are liable to occur in and about our railroad station, I have no doubt the different roads centring here would deem it a privilege to do something towards fitting up rooms for this purpose, as they have done in other cities.

As a member of the Board of Health I have had but little to do, as the city marshal is the executive officer, and generally attends to the complaints without being obliged to call a meeting of the Board; but the subject of ventilating our sewers having been referred to the Board for a report thereupon at some future meeting of the city council, it has been thought proper that such report and explanations be made at this time, that the public may receive the greatest benefit from the construction of sewer mains.

Feeling that the matter of ventilating our sewers was of paramount importance to the public, the subject has been referred to Mr. Lund, who, having superintended the surveys for all our street mains, and given the subject that attention every sanitary engineer should in order faithfully to perform his duty, is fully qualified to express his views, and his report is submitted for your consideration.

I would also call your attention to the report of A. H. Crosby, M. D., on the Water Pollution of this city. This is a matter of serious import to the people of Concord; and, while we are doing so much to improve its sanitary condition by sewers and drains, we should not ignore the fact that pure water is one of the first elements of health, and should provide against any possible contamination of our water-supply.

Gentlemen, in conclusion, allow me to call your attention to the fact that our municipal regulations are very imperfect in the manner of collecting vital statistics; that our records of deaths and burials are kept in such a manner as to be of but little use for reference; that the statute in regard to the registration of births is not enforced, nor is there any way provided for the publication of registration returns.

This is a matter of interest to the public and the physician, as showing the relative sanitary condition of the several sections of the town, as well as the prevalent diseases to be guarded against.

Respectfully submitted,

G. P. CONN, M. D., *City Physician.*

February 22, 1877.

ON THE NECESSITY OF

A THOROUGH SYSTEM OF

MUNICIPAL SUPERVISION

OF OUR SEWERS,

BOTH PUBLIC AND PRIVATE, THAT OUR CITIZENS
MAY, IN THE BEST MANNER, UTILIZE
THEIR USE.

BY G. P. CONN, M. D.,

CITY PHYSICIAN, AND MEMBER OF THE BOARD OF HEALTH.

THE NECESSITY
OF
MUNICIPAL SUPERVISION AND REGULATION.

The removing from our habitations of waste and effete matter, by means of what has been termed water-carriage, has been fully tested in other cities, and is regarded, by all who have made the subject a study, as the best now known.

No one will dispute but that it is an expensive method, not only in manner, but in material. The question of utilization of sewage is being investigated by engineers and sanitarians in this country and in Europe; but until some way is developed, by far less expensive than any yet devised, we must use such as are acknowledged to be in good repute.

Irrigation has been tried in many places, but has not proved satisfactory to the friends of the system; for, while the expense so far exceeds the income, it is useless to expect it to come into general use, for the friends of the system advocate its merits on the broad ground of utility, and have in Europe obtained charters, organized stock companies, and purchased land to carry out this idea. I do not know that any enterprise of this kind has proved a financial success.

The changes of temperature incident to our climate at once render all plans perplexing, and any system, that would be practically useless for four months or more in a year, should be passed by without further consideration.

The city having brought pure water into our houses, and constructed sewer mains in nearly every street, thus furnishing the channel and means of transmission, the question

naturally arises, Have you anything more to do, or will this investment take care of itself?

I think there are but few, certainly none that have given the matter any considerable attention, but that will answer that your work has but just begun; that a careful and vigilant supervision must be maintained; that the construction of private sewers must be attended to by competent persons, of known honesty and integrity; that the people must be made aware of the great danger they will incur if imperfect or misconstructured pipes are used, or unskilful workmanship is allowed, thus rendering this great expenditure of money in vain,—for a broken or misconstructured drain is worse for the health and happiness of those who use it than none; and not only those, but, by means of the subterranean communication thus established, all that have connection with the common sewer are exposed to the direful effects of another's carelessness or inefficiency.

Thus it becomes a matter of serious import to all who have entered, or who propose to enter, our street drains, that a rigid system of municipal supervision be exercised over every part of the whole plan, as in all matters of this kind there can be no discrimination between the rich and the poor, the mansion or the tenement. All have a common object in view, and all must be governed by the same rules and regulations.

That I may be better understood, you will pardon me if I call your attention to a few of the many dangers to be guarded against while our citizens are endeavoring to utilize the advantages you have so liberally presented for their use and occupancy. First, the sewer is intended to carry away our water-supply after becoming soiled, together with the various impurities from public and private buildings, the end and object being to remove all deleterious matters in such a manner that no offence be given to sight or smell. If this could be practically accomplished, so that all filth could be deposited in running water beyond the *termini* of

each section before fermentation or putrefaction was in any manner developed, your supervision would be unnecessary. Unfortunately, facts prove this to be a delusive theory, and that decomposition is a constant factor in all sewers, whether public or private, while the new compounds, developed by putridity, are direct agents of destruction to life to all living within the range of its contamination. Dr. William Stokes, one of the first authorities in Sanitary Science, says,*—“Sewers, streams, rivers, damp localities, collections of refuse—not alone of putrefying animal and vegetable matters, but of materials in no way offensive—have in turn proved to be manufactories of disease, not of cholera alone, but, in an enterprising mercantile spirit, of great variety, so as to suit the market.” Virchow † thinks that ordinary putrefaction will, under certain circumstances, all of which at present are not known, produce some of the Zymotic diseases, especially typhoid fever, dysentery, and diphtheria.

Liebermeister’s ‡ opinion is rapidly gaining ground among medical men, whether disciples of Pettenkofer’s germ theory or not, that filth furnishes a formidable foe to health, and a favorable *nidus* in which disease finds conditions ready for rapid development.

Pettenkofer, § fully believing in the germ theory, holds that a specific poison exists for Zymotic diseases, and that each disease can be produced only by its own virus or germ; and compares filth to charcoal in gunpowder. It is necessary to have it present in order to produce the explosion; but sulphur and saltpetre must also be there, and the mixture must be in the right proportions, otherwise the spark produces no fire.

In England sentiment is somewhat divided as to whether it is filth alone, or filth *plus* some particular germ or poison. Yet the fact stands unquestioned, that the removal of filth lowers the death-rate.

* Lectures on Sanitary Science, 1873. † Lectures in Berlin, 1874. ‡ Zur *Ætiologie des Typhus*, 1876. § *Zeitschrift für Biologie*.

Mr. Simon, chief medical officer of the Privy Council, and of the Local Government Board of Great Britain,* says,—“ A point that needs to be recognized by all who are in any way responsible for the prevention of Filth-Diseases is, that filth does not only infect where it stands, but can transmit its infective power afar by certain appropriate channels of conveyance ; that, for instance, houses, which have unguarded drainage communication with cess-pools, or sewers, may receive through such communication the same filth-infections as if excrement stood rotting within their walls ; and that public or private water-reservoirs, or water-conduits, giving accidental admission to filth, will carry the infection of the filth whithersoever their outflow reaches.” “ Thus it has again and again happened that an individual house, with every apparent cleanliness and luxury, has received the contagium of enteric fever through some one unguarded drain-inlet ; or that numbers of such houses have simultaneously received the infection, as an epidemic, in places where the drain-inlets in general have been subject to undue air-pressure from within the sewer.” “ Secondly, a very large danger to the public health, and particularly to the better-off classes of society, has of late years consisted in the recklessness with which house-drains, receiving pipes from water-closets, sinks, cisterns, baths, &c., in the interior of houses, and often actually within bedrooms or adjoining dressing-rooms, have been brought into communication with sewers. Among architects and builders there seems to have been very imperfect recognition of the danger which this arrangement must involve in event either of unskilful first construction, or of subsequent mismanagement or want of repair. Then, in regard to construction, an almost unlimited trust has been placed in artisans who, in not a few instances, have evidently failed to apprehend that even their mechanical work requires conscientious execution, so that under this influence there have been left in innumerable cases all sorts of escape-holes

* Filth-Diseases and their Prevention.

for sewer effluvia into houses, and disjointed drains effusing their filth into basements; while, under the other deficiency, house-drainage, though done with good workmanlike intentions, has often, for want of skilful guidance, been left entirely without exterior ventilation, and sometimes has, in addition, had the over-flow pipes of baths, or cisterns, acting as sewer-ventilators into the house. It is almost superfluous to say that, under circumstances of this sort, a large quantity of enteric fever has been insured; and I should suppose that also a very large quantity of other filth-diseases must have sprung from the same cause." In our country, the members of the Massachusetts Board of Health have reprinted this Essay on Filth-Diseases, and say,—“ If the practical suggestions made therein were acted upon by all citizens, hundreds of lives, now annually doomed to destruction, would be saved, and the health and comfort of the people greatly increased.” As illustrating the extreme danger arising from decomposing filth, the investigation into the causes of an epidemic of typhoid fever which occurred in 1864 at the Maplewood Young Ladies' Institute, at Pittsfield, Mass., by several of the professors in the Berkshire Medical College, affords an instructive warning. There were in this building at this time, of teachers, students, and servants, a family numbering one hundred and twelve persons; of these, fifty-six, or fifty per cent., had typhoid fever, of whom sixteen died. This epidemic occurred, too, in a season when, in a town of eight thousand inhabitants, all the physicians in practice testified that, aside from the cases at the institution, there was but very little typhoid fever, and none that proved fatal.

Had this been other than a local cause, and the inhabitants of the whole town been afflicted in the same ratio, there would have been four thousand cases of typhoid fever, with eleven hundred and forty deaths. It was, “ however, so entirely local, that some physicians in Pittsfield had no cases, others only two or three.” Prof. Palmer says of this epidemic,—“ Before the investigation the matter was spoken of

as an act of a mysterious providence, to whose rulings all must submit. Looking with the eye of science upon the overflowing cess-pools and reeking sewers as inevitable causes, and with the eye of humanity upon the interesting and innocent victims languishing in pain and peril, or mouldering in their shrouds, I could but regard such implications of providence, though perhaps sincerely made, as next to blasphemy, especially when uttered by agents who were to be held responsible,—though the prayer of charity might have been, ‘Father, forgive them, they know not what they do.’”

The sanitary reforms recommended by the Investigating Board of Physicians being carried out, Maplewood became and still remains free from diseases attributable to misconstructed sewers.

Dr. Bowditch long since gave the profession, as an aphorism, “All filth is an absolute poison;” and a sewer, being the receptacle of all manner of filthy material, may be considered as the typical *Upas-tree* that we should at all times guard our families from, it being one of those necessary evils that the massing of population requires.

This poisonous sewer gas cannot be clearly defined as it appears in its most dangerous form; but it is believed to be some product of organic matter undergoing decomposition in the presence of superabundant water, and in the absence of light and free ventilation. The dangers to which we are liable, and the necessity of public supervision, become more and more self-evident as we investigate the causes of disease. Col. Waring,* Civil Engineer, says,—“In doing away with cess-pools, and substituting sewers, unless proper precautions are taken, we simply make an elongated cess-pool, rarely sufficiently cleansed, and often grossly foul, and communicating with the interior of every dwelling-house. If typhoid excreta are thrown into a sewer a mile away from us, we have no security against the danger that its poisonous contagium will not float in the gas of the sewer, and enter our own

* Sanitary Condition of Houses and Towns.

living-room." "This is a grave difficulty, but it may be almost entirely removed by a proper arrangement of the drainage-works of the house itself."

Again he says,—“ Singularly enough, no one whose premises are subject to these influences seems willing to be told the truth with regard to them.” “ No man likes to confess that his own well and his own cess-pool occupy the same permeable stratum in his garden ; that decaying vegetables in his cellar are the source of the ailments in his household ; or that an obvious odor from his adjacent pig-sty, or from his costly marble-topped wash-stand, has to do with the diseases his physician is contending against.” “ That the imperfections of our own premises are a nuisance to our neighbors is a still more irritating suggestion, and such criticism seems to invade the domain of our private rights.” “ Yet surely there can be no equitable or legal private right, whose maintenance endangers the well-being of others,—as our widespread disregard of the defects in our own houses *does endanger* the well-being of our fellow-townsmen.”

The following from the pen of Dr. William Child, in a report to the New Hampshire Medical Society,* commends itself as a self-evident truth to any one who has had occasion to investigate cases of this kind. He says,—“ The people are not only apparently ignorant of the most common sanitary laws, but have a morbid sensitiveness on the subject. You may maltreat a man, and he will grant you pardon ; but suggest to him that his cellar is not clean, or that his drains are bad, or that his well is contaminated, or his privy is disgustingly odorous, and he will never forgive you. He calls you to treat his sick with drugs, not to tell him of his sink-drain or water-closet. He is willing that you should pocket a fee, but do not suggest to him that his premises are disagreeably filthy. He will follow his family to the grave, but you must not disturb that little but lively devil, *personal pride*.” I presume there is scarcely a physician in this city,

* N. H. Med. Soc. Trans., 1875.

who has not, while seeking for information as to the probable cause of some enteric disease that affected his patient, had the truth of the above forced upon him, perhaps sometimes more forcibly than elegantly expressed.

I trust enough has been said to show some of the possible dangers consequent upon the introduction of our sewers; and, as people have to be educated in the use of everything that is new to them, it may not be out of place to give a few hints as to what is absolutely necessary in order that we may attain the object for which they were intended.

I believe it is universally acknowledged by all who have given the subject any serious consideration, that it is of prime importance to have all sewers thoroughly ventilated; and, as Mr. Lund will in another place give the results of his investigations, especially concerning the mains, I will only refer to the necessity of ventilation of our private drains for our own protection.

Mr. Simon, to whom I have before referred, states, in his report of 1874, the following, as imperative conditions that should be insisted on whenever water-closets are allowed:

“1. That the closets will universally receive an unfailing sufficiency of water properly supplied to them.

“2. That the comparatively large volume of sewerage that the system produces can be in all respects satisfactorily disposed of.

“3. That on all premises which the system brings into connection with the common sewers, the construction and keeping of the closets, and other drainage relations, will be subjected to skilled direction and control.”

In his explanatory remarks, he states “that a sufficient supply of water is a supply that will enable each closet to be well flushed whenever used, and that the supply must be not only professedly, but actually constant. The best way to secure this is to supply each closet from an independent cistern immediately above it. That every privy drain must be properly trapped and ventilated, and properly constructed, ventilation of the soil-pipe above the roof being imperative.”

Dr. De Chaumont says,—“ Under no circumstances ought there to be a water-closet opening directly into a bedroom, the merely occasional convenience of such an arrangement being more than counterbalanced by its danger, and generally objectionable situation.”

Col. Waring states, in regard to house drains,—“ That, from a sanitary point of view, a most important feature is a complete ventilation of the drain leading to the sewer, so that by no possibility can there be a forcing back into the house of gases formed in the sewer, or in the main drain. As already stated, a usual water-trap, no matter how deep, does not suffice to secure this. A water-trap having a bend of even two feet would resist a pressure of only about one pound to the square inch, while a sudden filling of the sewer, by rising tide or falling rain, to such an extent as to reduce its air-space one half, would bring to bear a pressure of fifteen pounds to the square inch ; and, whether the filling be sudden or gradual, the degree to which the increased pressure would affect any given outlet would depend on the facilities offered elsewhere for the air to find vent. In our ordinary town sewerage works, it is never safe for the householder to depend on other vents than his own connecting drain being available. He must in self-defence assume that his own drain is the only channel of escape, and make it impossible that air escaping there should find its way into the house.” All offensive smells proceeding from any works intended for house drainage, indicate the fact of the detention and decomposition of ordure, and afford decisive evidence of mal-construction, or ignorant or defective arrangement. A sink without a trap, or an open cess-pool or drain, thus allowing sewerage air to find access into our dwellings, cannot fail to produce a pernicious effect upon all who may be brought within its influence.

These important matters have been too much neglected, and it cannot be doubted but that very serious results follow the neglect of the proper means to preclude the escape of the

poisonous air generated in sewers and drains. As has been observed before in this paper, the evil effect of sewerage air is not confined to the premises at fault. The closest observance of sanitary rules avails one but little if his neighbors give no heed to its claims upon health. Hence the importance of a thorough inspection and supervision of the construction of drains, and a speedy remedy of any defects that may be made apparent.

The importance of this subject claims your attention, as well as those who, in their professional character, are entrusted with the care of the public health.

We often hear it said, by persons in apparently sound health, that the conditions under which they live must be good and healthful, because they do not suffer. Again: we are told that all this talk about filth, as a cause of disease, is a fraud, a hobby of medical men, and, in support of this theory, will refer you to this or that family or neighborhood, living in apparent health amidst surroundings that are surely repulsive to the sight and smell. Much self-deception is practised in this way. Unwholesome influences may for a long time be resisted by a vigorous constitution, yet the time arrives at last when they show their power.

It is difficult to explain why an intelligent appreciation of disease, and a reasonable knowledge of the ordinary means of its prevention, are so slow in forcing themselves upon the attention of communities.

In our city, those having water-closets in their dwellings have put in the so-called pan-closet, which is condemned by those who have made the system a study. Mr. Waring, who has been quoted before in this paper, says,—"The usual pan-closet is in several ways objectionable; chiefly, as containing in the chamber beneath the pan a certain quantity of fouled water, above which is an unventilated air space—sometimes, from imperfect construction, leaking its gases into the room, always sending up a foul whiff when the pan is tipped." Baldwin Latham, who stands unquestioned as authority in

Sanitary Engineering, speaks of it "as a cumbrous appliance, which cannot be introduced into a house without sooner or later creating a nuisance." Mr. Philbrick, C. E.,* says,— "Its defects are numerous, but its great defect arises from the reservoir of foul air always present in the iron receiver below the crockery bowl. The inside of this receiver is necessarily foul; it is quickly smeared with filth when first put to use; its interior is inaccessible, and can therefore never be cleansed. Directly below is the large metal trap, whose contents generally emit noxious gas from their decomposition; and this trap cannot safely be dispensed with. Whenever the pan is tilted and discharged, there is suddenly dropped into this receiver several quarts and sometimes a pailful of water. This must, of course, displace its own volume of the foul air pent up there, for which there is no escape in any direction but upward, with a rush past the tilted pan into the bowl, when it mixes freely with the air of the room." Another reason is, that the bowl and receiver are connected together with a putty joint, as well as the water-pipe connection. This practice among plumbers is but little better than a rag packing; for in our climate the changes from heat to cold, alternately expanding and contracting the metal, are sure to make cracks in the joints,—and, even if they did not crack, it is a well-known fact that sewer gas will find its way through putty, mortar, or cement;—therefore cement-pipes must be glazed in order to answer the requirements of house drainage.

I do not lay any claim to originality in this paper. These facts have been published again and again in works on Sanitary Engineering, and any one who will take the trouble may inform himself on all these important points. It would be well if more would do so; for, * "however well a system of house drainage may be planned and constructed, it cannot be expected to be entirely automatic, or serve its owner for an unlimited period, without intelligent supervision. In fact, 'eternal vigilance' is the price of safety in such

* Mass. Board of Health, 1876.

matters in a climate where such violent and sudden changes occur as in ours. Sometimes a trap may freeze in January, and dry up in July ; deep frosts sometimes break up drains and leave them leaky ; rats burrow into and gnaw into drains, if not thoroughly built ; the gases given off by sewage often corrode lead pipes, and the ammonia in water-closets corrodes the copper pans ; valves become leaky by wear ; counterpoises get loose. But frost is our greatest enemy : a frozen water-pipe often does much damage, but a frozen drain is the climax of discomfort. With the extended use of plumbing come the increased risks of such mishaps.

“ The risks of leakage of drains are of course very serious, and the difficulty of tracing such troubles to their sources renders it imperative to keep a careful record of their position, and to take alarm from the only sense by which we can often be led to detect them, acting vigorously to repair the defect when found.”

Instances might be cited to show how little is known about ventilation, water-traps, or the materials that should be used in the construction of private drains.

Let us have rigid municipal rules and regulations to govern and guide our citizens, and a competent and judicious supervisor or superintendent, to whom any and all may apply for information and advice, who will carefully investigate into every individual case, and see that nothing is left undone to secure exemption from the evils incident to a neglected or misconstructed sewer or private drain.

Then we can rest assured that an accidental sporadic case of any infectious disease, occurring in any part of our city, will not, by reason of negligence or ignorance on the part of the friends of the patient, communicate the same infection to their neighbors on the same street, or to others residing a mile away on the hill-side, perhaps in blissful ignorance that a case of infectious or contagious disease exists within the limits of the city.

If any have connected their premises with our sewer mains,

and not done it in a thorough manner so that there can be no risk with ordinary care and supervision, let them attend to it at once, and do so intelligently,—never trusting to the artisan, who has no interest beyond the number of his days' work, and, oftentimes, has no better recommendation than that he can make a good looking joint outside, though water will scarce run through the pipe from its imperfections within.

To others, who intend to make use of our sewers, I would say, "Go slow." Be sure you fully understand what you want in the way of drains and house-pipes before you begin, and then see that none but the best materials and workmanship are used, and you will have fewer troubles in tearing out and building over, and less anxiety for the safety of your families.

ON THE
IMPORTANCE OF VENTILATION
IN A SYSTEM OF
SEWERAGE WORKS.

BY CHARLES C. LUND, C. E.

VENTILATION OF SEWERS.

The experience of the winter has made it obvious that some attention must be given to this subject at an early date. The results foreshadowed by my articles, published in the *Monitor* last fall, have already been produced in the more elevated portions of the city; and, inasmuch as this report will be placed in a more permanent form than the articles above referred to, I may be pardoned if I repeat some of the suggestions there made. I may also state that I do not claim that the suggestions here offered are to any great extent original. I shall quote freely from the works of the sanitary engineers who have written upon this subject, my object being simply to put before our citizens information gathered from sources which are not generally accessible to persons who give no special attention to the matter.

The evil effect of sewer air upon the public health is not a modern discovery, for it appears that in the flourishing days of the Roman empire "the prætor took care that all the sewers should be cleaned and repaired for the health of the citizens, because uncleaned or unrepaired sewers threaten a pestilential atmosphere, and are dangerous." They had a clear knowledge of the necessity of ventilation for underground conduits, and made provision for such ventilation in the construction of their aqueducts where they pass beneath the surface. The Cloaca Maxima was one of the most perfect and stupendous works of that age, and was kept in a state of efficiency by a stream of surplus water from the aqueducts. During the republic, the surveillance of the cloacæ was one of the duties performed by the censors. They

were subjected to repair by Cato, and his colleague in the censorship, Agrippa, when *Ædile* obtained praise for his exertions in cleansing the cloacæ, and is reported to have passed through them in a boat. Many of their ventilating shafts are still in perfect order, after a lapse of nearly 3,000 years. They were constructed at intervals of about 120 feet, and served for ventilation, and admitting light and air and workmen to make repairs. An examination, made by Mr. Cresy, of the drainage works of the Coliseum at Rome, revealed drains constructed within its massive walls so as to be entirely hidden from view, which conducted away the sewage and rain-water, and that careful provision was made to prevent the odor therefrom from entering the building.

Every descending drain was open at its head, and the heads of all the drains of the building terminated in the outer corridors, which were open to the atmosphere.

The dangerous elements which exist in sewers are either the direct contagion of infective diseases from the dejecta of sick-rooms, or the result of the decomposition of animal and vegetable matter which finds its way to the sewer from our sinks and water-closets. The gases produced by decomposition of animal matter, though offensive to the smell, are not particularly dangerous to health. But the results of vegetable decomposition are most fatal to health, while some of the most subtle and deadly vapors arising therefrom cannot be detected by their odor.

Thus, the proximity of slaughter-houses may be very offensive by reason of the animal matter in various stages of decomposition almost inseparable therefrom, but they do not create an unhealthy neighborhood; but the proximity of undrained swamps, where vegetable matter is in a constant state of decomposition, is most unhealthy, producing fevers and epidemics.

The gases found in sewers are carbonic acid, nitrogen, carburetted hydrogen, sulphuretted hydrogen, ammoniacal compounds, and fetid organic vapor.

Carbonic acid is produced by all the ordinary processes of combustion—by respiration, fermentation, and by the decay of animal and vegetable products. When diluted with air it may be breathed without difficulty, but if the proportion in which it exists in the air exceeds four per cent., it acts as a narcotic poison. A proportion of ten or twelve per cent. is speedily destructive to animal life, and so small a quantity as one or two per cent. is deleterious and depressing. The drowsiness and headache experienced in crowded and ill-ventilated apartments are chiefly due to carbonic acid as the resulting product of respiration.

Nitrogen is one of the most abundant of the elements. It will not support life in its pure state, yet it has not been shown to be a poisonous gas. It constitutes four fifths of the atmosphere. It is found largely in animal, and, in small quantities, in vegetable products. One fifth of the weight of dried flesh is nitrogen. It is colorless, tasteless, and odorless in itself; but organic bodies which contain a large amount of nitrogen emit a most offensive odor when they decay, and a peculiarly offensive odor when they are burned. The odor occasioned by the putrefaction of human flesh, which is rich in nitrogen, is one of the most offensive in nature.

Carburetted hydrogen is a constant product of the decomposition of wood and other carbonaceous bodies, under water. It is the gas which arises when the mud is stirred in the bottom of stagnant pools, and, in connection with atmospheric air, forms the explosive compound known to miners as fire-damp; and it is therefore unsafe to enter an unventilated sewer with naked lights. It explodes with great violence; and care should be taken to ascertain as to its presence before introducing lanterns into the lamp-holes for purposes of inspection of sewers.

Sulphuretted hydrogen is always present in sewers in which the sewage has assumed a certain degree of putridity. It has a disgusting odor, like rotten eggs. It is heavier than

air, and burns with a blue flame, with a smell of sulphur. It is the most poisonous of all gases of known composition, and when present in very small quantities is fatal to the lower orders of animals. When inhaled, it acts directly on the blood, thickening it and turning it black. It is this gas which makes an open or foul sewer so destructive of health to any district in which it may be situated. It is produced in large quantities in sewers and cess-pools by the decay of organic matter, and its presence may often be detected in marshes, where vegetable matter alone is undergoing decay. Experiments show that one of the gas to two hundred and fifty of air will kill a horse; one in five hundred will kill a dog; one in fifteen hundred will kill small birds; and a rabbit was killed in a few minutes by being placed in a bag of this gas, though its head was not enclosed, and it was free to breathe pure air. Numerous deaths have been recorded in times past among the workmen employed in emptying cess-pools in which this gas had accumulated.

Ammonia is produced during the decomposition of animal and vegetable substances which contain hydrogen and nitrogen, and in almost every process of oxidation in the presence of moisture. It has an extremely pungent smell, and instantly kills an animal immersed in it, but when largely diluted with air is an agreeable stimulant.

But little is known of the nature and composition of the foetid organic vapor, which is more or less present in all sewers; yet it is conceded to be the most subtle and dangerous matter present in the sewer. It is either in itself the cause of disease, or it causes the germs of disease which float about on the air of sewers. It is not distinguishable by any characteristic odor, like the gases above named. This vapor can be effectually absorbed and destroyed by the use of charcoal.

Experiments made by Dr. Letheby (says Latham) on the generation of sewer gas from sewage, show that a gallon of sewage, containing 128.8 grains of organic matter, gave in

nine weeks 1.2 cubic inches of gas per hour, consisting of 73.833 of marsh gas, 15.899 carbonic acid, 10.187 of nitrogen, and 0.081 of sulphuretted hydrogen. But this was a laboratory experiment, and gave larger results than would be probably obtained from sewage taken at random from our sewers.

The effect of this sewer air upon the health of a community, and the diseases which are directly traceable thereto classed as Filth-Diseases, will be set forth in another portion of this report.

In the construction of a system of sewerage, it would be desirable to give the sewers so great a pitch that the contents thereof would pass quickly away before decomposition could take place; for it is the *decomposition* of the organic matters found in sewage that liberates the harmful elements above described.

But in practice many instances will occur where grades must be so flat that the ordinary flow of water will not be sufficient to carry along the solid matter, and it will lie as if in a cess-pool until flushed out by storm-waters, or by an artificial flow introduced from the hydrants. Some seasons many weeks will elapse before the flow from storm-waters will be sufficient to accomplish this, and in the mean time gases are generated which will constantly be seeking an avenue of escape into houses through the sinks and privy drains, unless the most thorough precautions are taken against them.

The expansion of the sewer air by heat; the natural draft upwards through the main sewers, as through a chimney; the rarefied air of our houses, by reducing the atmospheric pressure on the traps; the displacement of the air in the sewer, by varying ebb and flow of the sewage; the wind blowing into the outlets; the expansive nature of the gases themselves; variations in barometrical pressure,—all tend to expel the sewer air through the various openings made to admit the sewage itself; and against these forces we interpose

the water-trap, which, without the aid of ventilation, will prove an insufficient barrier. The power exerted by the forces above specified is very much underestimated. It is easily demonstrable to far exceed the resisting power of the traps in ordinary use ; and it acts with greatest intensity in the more elevated portions of the system. And gentlemen who have established their residences on the hill for the purpose of obtaining pure air, should take especial care lest their locations become the most unhealthy by reason of the transference of the sewer gas from the lower portions, to find its easiest escape into their kitchens and bedrooms by way of their sink drains, and by the waste-pipes to their fixed wash-basins and bath-tubs. I might cite numerous instances where whole communities have suffered from epidemics of typhoid fever, directly traceable to this cause alone. It is to be constantly borne in mind, that the householder, who connects his house-drain with the public sewer, has not only to protect himself against the results of the decomposition of the waste matters of his own house, but also from all other houses whose drains empty into the river by the same outlet ; and it becomes of the first importance, now that we have got our system of sewerage, to learn so to take care of it and use it that we may realize the great benefits which it ought to confer. Our system of sewerage—I mean what is known as the water-carriage system—is undoubtedly the best yet devised ; but it requires the utmost care on the part of the individuals using the drain to make the plumbing arrangements of their houses perfect.

The antidote and preventive to be employed against the sewer gas is ventilation. So great a purifying power resides in the atmospheric air, that it burns up the harmful elements, liberated by decomposing matter, as by fire. It purifies by oxidation, which is a slow combustion ; and, if we can mingle sufficient pure air with the tainted air of our sewers, we shall have no trouble. And so our house-drains should be so constructed that currents of pure air may be

induced through them ; and, above all, so that sewer air, if it is forced through the traps, should find an escape outside the walls of our houses.

The thorough and systematic ventilation of the public sewers themselves is of great importance, because it adds to the security that the house-traps afford by furnishing an easier escape for sewer gas than through the trap ; and if such ventilation were provided, probably the ordinary traps in use would be sufficient to bar the passage of air from the main sewer into our houses. They would act as safety-valves, so that pressure enough to force the traps could not be brought to bear. But it is not easy to suggest a system of ventilation for our street mains that shall be effective in this climate, and under the conditions which must always exist here. A system of ventilation by the man-holes, which are provided with perforated covers, is the best yet known, either with or without the use of disinfectants and deodorizers. But such a system would be ineffective here for half the year, when snow and ice would completely seal up the vents. During the present winter there has been absolutely no ventilation for our sewers, except through the catch-basins left untrapped, and on the hill a few of these basins have furnished all the ventilation which has been had ; and the residents near the localities of these basins unite in the testimony that the odors therefrom are not apparently fresh "from the spicy groves of Araby the blest." When two or three outlets of this kind do duty for a whole city, we should expect a pretty strong odor.

There have been numerous theories and experiments, for many years, having reference to this subject of ventilation of main sewers, and the prevention of the formation of sewer gas : The deodorization of sewage by chemical agents, as it flows through the sewers, has been proposed ; absorbing materials, placed within sewers to absorb the sewer gases as they were generated ; chemical agents, introduced to give off gases which might destroy the noxious properties of sewer gas ; elec-

tric and galvanic agency has been proposed as a means of destroying the noxious properties of sewer air ; suggestions for the use of high shafts, or chimneys, aided by artificial heat, have been made ; a very common proposition is, to make use of chimney shafts of manufactories, but such use naturally interferes with their use as chimneys ; special pipes, usually of metal, have been carried from the crown of the sewer under the roadway, and up the external walls of adjoining houses ; rain-water pipes have been adopted for ventilation, but not with good results—on the contrary, with very fatal results—and they were obliged to be abandoned ; ventilation by means of the lamp-posts, assisted by the heat evolved from the gas jets ; cowl-headed shafts, operated by the wind ; and other devices too numerous to mention,—all have resulted in failure as ventilators. But the system of conducting metallic pipes from the crown of the sewer, up the walls of adjoining houses, acted efficiently in allowing the air to escape when it became compressed, so operating as a safety-valve.

The system of ventilating by means of man-holes, having perforated covers placed at frequent intervals, not exceeding two hundred feet apart, in the centres of streets, has proved most effective in milder climates than ours. The object has been to take a small portion of the gas at every man-hole, and thus discharge it as fast as it arises in any part of the system. Some of these man-holes will act as down-cast shafts, and some as up-cast shafts ; and the varying conditions of the atmosphere will induce currents of air through the sewers, which accomplish the desired results. But, as before remarked, it is essential to the success of this method that the man-holes be kept open, and this would be practically impossible in this climate during the winter months. I am as yet unable to learn how this problem has been solved in any other city whose climate and situation is similar to our own. The climate of Lowell is milder than that of Concord, of course, but the conditions are somewhat similar a portion of the year, and the report of Mr. David W.

Cunningham, engineer, in 1873, informs us that the simple method of leaving the street gully untrapped, and with an open iron grating, has been, and still is, employed in Lowell as the only ventilation. He says,—“The effect of it is, that the offensive gases are thrown out into the streets at the edge of the sidewalk, and too near the front doors and windows of houses :” and further adds,—“that the best method he can suggest for economical ventilation, and that giving the least annoyance, will be to perforate the iron covers of the man-holes in the centres of the streets, and to connect the rain-water pipes from the houses with the sewers without traps : and this is the plan now generally adopted.”

It is objected, however, that in times of storm, when large quantities of water are passing into the sewer through the gullies, and, of course, displacing as much air, which is trying to escape, the water will also be passing into the sewer through the rain-water pipes, and thus preventing their doing duty as ventilators in times when they are most needed. But in the summer season, if *both* the rain-water pipes are connected and man-hole covers perforated, they might, together, furnish sufficient ventilation during the summer, but in the winter we should be compelled to rely on the water-pipes alone.

Mr. Shedd, the chief engineer of the Providence Water-Works and sewer construction, employed perforated covers to the man-holes alone, as I gather from his report in 1874. He has placed man-holes at intervals of about one hundred feet apart on the smaller sewers, and varying distances, greater than this, on the larger ones, so that the sewers may be easily inspected and obstructions removed. In our Concord system we have not placed man-holes as frequently as perhaps we ought, because of their cost ; and I am inclined to think that additional ones will be found necessary after a little experience. Such was the result in the city of Worcester, where they had, from motives of economy, left long intervals between the man-holes in the original construction of the sewer.

Such openings should be made sufficiently often to enable the sewer to be easily and conveniently inspected and cleansed, and a neglect to provide these necessary appurtenances to our sewers when they are being constructed is a mistake. Frequent man-holes are necessary in all sewers, and the smaller the sizes the oftener should the man-holes be inserted, especially on the flat grades. They are necessary as ventilators ; they are necessary for the proper inspection of the sewer ; and, in case obstructions begin to form in any small sewer having man-holes at one hundred feet intervals, the obstructions can be removed without taking up and re-laying. With man-holes at long intervals, the sewers can neither be inspected nor properly flushed, and the result is, that the difficulty of cleansing leads to postponement of the work until the complete choking of the sewer compels it to be done, and then the sewer must be uncovered, broken into, and patched up, to its material and permanent injury ; and in the mean time the choked sewer is an elongated cess-pool, full of all manner of filth, putrefying and festering corruption, sending its foul odors and deadly miasmata abroad. And when the angel of death spreads his wings in our midst, and children, tender women, strong men, succumb to the pestilence bred in such a sewer, *as I fear they already have here in our own city*, it is not a visitation of Providence, but the penalty for the almost criminal neglect of the most obvious precautions.

And this leads to the subject of keeping the sewers clean. As I have before remarked, it has not been found practicable in this city to give so great a pitch to all our sewers that they will keep themselves clean by their own flow. They would carry away, even in the flattest places, a vast amount of pure water, but much of the sewage is not sufficiently diluted to flow away freely, and obstructions are liable to occur at any time, in any sewer, by reason of improper substances which find their way there. We should expect more or less sand from our unpaved streets ; but

shavings, sticks, coal, bones, garbage, bottles, spoons, knives, forks, apples, potatoes, hay, shirts, towels, stockings, floor-cloths, broken crockery, old clothes, boots and shoes, are but a portion of the substances found in the sewers, which have no business there, and which they are not intended to carry away.

I have never yet heard of a housekeeper vigilant enough to prevent a servant girl from thrusting everything which she wished to get rid of down the sink-spout, provided only that the sink-spout is large enough to receive it. To accomplish this, either the sink-spout or the servant girl must be abolished. I have no doubt that if these dumb receptacles had tongues with which to speak, they would answer the often repeated conundrum, Where do things go to?

Convenient facilities for inspection, and opportunities for flushing, intelligently employed, ought to keep our entire sewerage system in as cleanly a condition as sewers are ever capable of being kept; and, if so kept free, the dangers from sewer gases are much diminished, because of the prompt removal of the matters in which they have their origin. Such timely attention and flushing will do much to help out insufficient ventilation, and to render the exhalations from the ventilators less offensive.

Experience has shown that the points in a line of sewer where obstructions are most likely to occur, are found a short distance below the point where a steep grade intersects a flatter one—as at the foot of the high land on Pleasant, School, Warren, Centre, and all streets coming down from the hill to the more level land below. The swift flow of the water down the hill is checked at the foot on the flatter grades, and a kind of reaction takes place, which precipitates the material held in suspension in the swift flowing water, and sometimes packs it so hard that flushing cannot remove it until it is loosened by dragging. Such obstructions may be removed by a claw drawn from man-hole to man-hole by means of a rope, a smaller cord having first been passed

through by a float, by means of which the rope attached to the drag or claw is drawn through the sewer. It is rarely found that such obstructions make it necessary to take up a sewer, provided sufficient man-holes are constructed, and timely attention is given.

Having constructed our sewers, the next subject which demands attention is the manner in which the house-drains are constructed—a subject which comes more particularly within the province of the architect and builder, and demands the individual attention of every householder and tenant, as well as the general supervision of the public authorities ; for, however well sewers may be built and arranged, if the house drainage is imperfectly or unskillfully executed, it will bring its train of evils to plague us. In this subject the public also have an interest. No man has the right, by incurring the risk of disease in his own family, to endanger others to whom his disease may be communicated. I propose to make a few general suggestions as to the manner in which such drains should be constructed.

It should be first borne in mind that the prime object should be to remove refuse from the premises with all possible speed ; and where cess-pools or grease-pots are constructed, because of the need of separating the grease from kitchen drains, they should be as small as possible.

The drains should be no larger than is absolutely necessary to perform their office, and there is little danger of making them too small ; all increase of size above what is absolutely necessary is an injury, by diminishing the scouring power of the current. There is probably no building within the limits of our sewerage system, including the asylum for the insane and the state prison, that would not be amply drained by a 6-inch pipe, laid with a fall of from $1\frac{1}{2}$ to 2 feet per hundred. Col. Waring, in his recent book on the Sanitary Drainage of Houses and Towns, relates an instance which illustrates the capacity of small pipes. A 6-inch drain pipe was laid to drain a single house. Other houses were built adjacent, and

the drain was extended to accommodate them, and so on, until, after the lapse of a few years, *one hundred and fifty houses* were connected with that 6-inch drain, which answered its purpose perfectly, and kept itself clean, and gave no trouble. Of course, the drain was used only for the waste of the families, and not for storm-waters.

A 6-inch pipe, laid with a fall of 1 in 100, will discharge 41.75 cubic feet of water per minute, or 587 barrels per hour, if running full—an amount far exceeding the probable requirements of any institution within our city limits. A 4-inch pipe, under the same circumstances, will deliver 15 cubic feet per minute, or 211 barrels per hour.

All house drains should be trapped, and the place where the trap should be located is outside the house walls, on the main house drain, after it has collected all its branches; and this trap should have a ventilating pipe of say 4 inches in diameter, leading from the hole in the trap up the side of the house, like a rain-water spout, to the highest points of the roof, so that sewer air, if forced through the trap, may there escape.

Cement-pipe is not a suitable material for drains inside the house or under it. It is too porous to stop sewer gas. Iron, with lead joints painted, makes the best material for this purpose. Mr. Philbrick, on the subject of House Drainage, in the Report of the Massachusetts Board of Health for 1876, states that he has seen a drain well laid with Scotch pipe and full cement joints, and covered with a concrete of hydraulic cement on the cellar floor, giving off, through the cement, an amount of stench that made the cellar nauseous, even though the soil-pipe above was ventilated. Metallic pipe, not buried under the cellar bottom, but carried along above it, with well caulked joints, painted, and so placed that it can be easily inspected and repaired in case any leakage shows itself, is the best possible material for drains inside houses.

The trap outside the premises is intended to stop gas from

the main sewer. It is obvious that more or less decomposition will take place in the drain-pipes leading into this trap. This should be most carefully guarded against. It is a common practice in our best modern houses to place wash-basins in sleeping-rooms, and in dressing-rooms opening directly into sleeping-rooms. The most careful provision should be made for trapping and ventilating the waste-pipes to these conveniences, so that by no possibility can they act as conductors of foul air from the drain into the room. To accomplish this we must imitate the example of the Romans, nearly three thousand years ago, and let the head of every drain terminate in the open air outside our buildings.

The idea of inserting the head of the drain into the chimney is a popular one, and at first thought would seem to be a good one, that the draft of the chimney might effect the necessary ventilation. I can only say that those who have tried this method have been compelled to abandon it, so far as I can learn. The better way is to carry the soil-pipe, full size, up beside the chimney if possible, through the roof.

It is easy for the architect to provide for this in the construction of new houses; and in houses already constructed, where plumbing arrangements are introduced, such arrangements may be made at small expense. Those who have the means usually have the desire, also, to make these arrangements perfect in this respect; but those whose means are more limited are apt to neglect such precautions, because they think they cannot afford it, and perhaps they do not sufficiently appreciate their importance. No man is so poor that he can afford to neglect them, or so poor that he need be filthy. He cannot afford the expenses of sickness and death in his family consequent upon breathing the foul exhalations from the public sewer. I have endeavored not to overstate the dangers that threaten us as a community if the subject is neglected. We have no right to suppose that our experience will differ from the experience of other cities in this regard. I have only stated facts well known to every

man who has given attention to this subject, and which may be verified by anybody who will take the trouble to make the investigation for himself. It is a subject on which I might write a volume. The entire report of Mr. Philbrick, above quoted, as published in the Report of the Massachusetts Board of Health, is worthy of being republished here for the practical information it contains on the subject of house drainage; and those who are putting in house drains cannot do better than follow its most excellent suggestions.

NOTE.—Dr. A. H. Crosby's report on the "Water Pollution of this city," not having been furnished to the printer in season, is necessarily omitted here.