amounts varying from 0.2 to 0.5 part per million of the rain water. The improvement in fields which are permitted to lie fallow has been attributed to ammonia in the rainfall, but this ammonia is manifestly inadequate to account for the masses of vegetation which annually find nourishment in the soil. The ammonia originating on or in the soil during the decomposition of its organic matters is the source of the nitrogen which feeds the living plants. A trace only of this ammonia escapes into the air and is afterward washed down with the rain. Prior to its use by the vegetation which covers the surface of the earth, it is nitrified by bacteria which are everywhere present in the upper layers of the soil. Some of the lower forms of vegetable life, such as certain algæ and bacteria, absorb nitrogen directly from the atmosphere. Some leguminous plants also fix atmospheric nitrogen in their tissues, but this is accomplished indirectly through the medium of parasitic bacteria found in nodules on their roots.

The ammonia of the air is condensed on exposed surfaces, and R. A. Smith has suggested that the quantity of ammonia deposited on a given surface in a given time may be taken as an exponent of the sanitary condition of the atmosphere. A glass or other surface which has been exposed for some time in an unventilated bedroom, when washed with pure water will show in the washings the presence of a readily determinable quantity of ammonia; but the attempt to demonstrate the relative purity of atmospheres by the quantity deposited on equal and similar surfaces in equal periods of exposure meets with failure unless the temperature, the hygrometric condition, and the air movement are the same in both instances. This concurrence of similar conditions is difficult, if not impossible, to obtain in practice.

Watery vapor is constant in its presence in the atmosphere, but, as we have already seen, in such varying quantities that it is viewed by many as an accidental constituent. Its importance, however, not only in the preservation of the purity of the atmosphere, but as a preservative of the vitality of all the organisms submerged in it, is so great that it must be regarded physiologically as an essential.

The air constituents which have been mentioned must be regarded, from the scientific and sanitary point of view, as individually essential to the constitution of the atmosphere. The oxygen is vital to animals, its quantity being preserved by the evolution from vegetation and the equilibrium established between these two kingdoms of nature. The carbonic acid is vital to vegetation, being the source of the carbon solidified in its tissues; its quantity is preserved by the evolution from animals and the retrogressive metamorphosis of the organic carbon of devitalized tissues.

Organic substances are those developed by the forces of life. They include all living bodies and those that have ceased to live, with many products of the life of the one and of the decay or decomposition of the other. With the infinite variety of animal and vegetable life constantly before us, it is needless to suggest the complex character of organic matters, but, notwithstanding this complexity, little more than the elements contained in air and water enter into their composition. Animal life depends on vegetable life for its sustenance directly, or in the case of carnivorous animals indirectly. Animals cannot combine the elementary bodies, but these are taken by plants and formed into organic substances, which animals are capable of utilizing as food. So complex are all vitalized substances that but for the preservative influence of their vitality, their molecules would speedily break up into simpler forms, and, indeed, when life ceases to protect them their putrefactive decomposition begins immediately and ends in their resolution into the very substances from which they were originally constructed. Nature moves in cycles. Day follows day and season season. The seed germinates and the grown plant matures its seed. Every generation is a cycle, and, in the instance before us, the elements from which life elaborated the highest organic structures revert to the inorganic condition of carbonic acid, ammonia or nitrates, and water for use in some succeeding cycle.

Even in the living organism similar changes take place. No machine works without wear. The tissues of the animal body are worn by exercise. The nitrogen of the worn-out tissues is removed by the kidneys as urea, which speedily becomes converted into ammonia, while the carbon is oxidized and the resulting carbonic acid is carried to the lungs to be expelled.

During quiet breathing twenty-seven cubic inches of air enter the lungs at each inspiration, and if the air be pure nearly six of these cubic inches are oxygen and only one one-hundredth part of a cubic inch carbonic acid. The air expired has less oxygen, more watery vapor, a taint of organic matter, and somewhat more than a cubic inch of carbon dioxide. Breathed air, therefore, contains a hundred times more carbon dioxide than is contained in an equal volume of the free atmosphere. The frequency and depth of the respiratory acts vary in the individual with his condition as to health, exercise, or repose; and as might be expected, they vary also in different individuals under the same or similar conditions. The average excretion of carbon dioxide by the human lungs can therefore be stated only approximately. Giving due consideration to the experimental results obtained by various qualified investigators, its amount may be stated to be at least 0.01 cubic foot per minute, 0.6 per hour, or 14.4 in the twenty-four hours. The energy of the vital actions concerned in respiration may be appreciated when we realize that in 14.4 cubic feet of this invisible gas we have nearly half a pound of solid carbon.

Although the inflow into the lungs is interrupted by expiration at comparatively regular intervals, the absorption of oxygen and evolution of carbon dioxide are coninuously in progress. The inspiratory inflow of 27 cubic inches mixes with the air already in the lungs and freshens it for the use of the system. Deep breathing washes out the lungs and permeates them with an air rich in oxygen and comparatively free from carbonic acid. No matter how pure the surrounding air may be, an individual may suffer from impure air in his lungs if by sedentary habits, or other cause, his breathing becomes shallow and insufficient.

Allowing 16 as the average number of respirations per minute, with an air movement of 27 cubic inches into and out of the lungs, the air respired in an hour would measure 15 cubic feet and in twenty-four hours 360 cubic feet, and with an output of 0.01 cubic foot of carbon dioxide per minute the respired air would contain 4 per cent. of this gas. From these data may be calculated the amount of dilution needful to bring respired air back to a condition of purity approximating that of the free atmosphere. If 15 cubic feet of breathed air containing 0.6 of a cubic foot, or 4 per cent. of carbon dioxide, be uniformly mixed with 99 times its bulk of air containing no carbon dioxide, the 0.6 cubic foot of this gas present would constitute 0.04 per cent. of the mixture; but in using atmospheric air for the dilution the percentage of carbon dioxide in the resulting 1,500 cubic feet would be nearly 0.08, inasmuch as each cubic foot of the diluting air brings with it the 0.04 per cent. of this gas which it naturally contains. But as the organic taint in respired air which has been diluted to this extent is perceptible by its odor to one entering from the fresh air, it is evident that this dilution is insufficient. Even when the carbon dioxide is diluted to 0.07 per cent., sensitive nostrils can detect the presence of the associated organic matter; but if the 1,500 cubic feet containing 0.8 per cent. be further diluted with an equal volume of fresh air containing 0.04 per cent. of carbonic acid, the mixture is reduced to 0.06 or six volumes in 10,000 volumes of the air, and with this dilution of 3,000 cubic feet per hour per person, sanitarians are satisfied, except in the case of certain hospitals.

It is easier to pass 3,000 cubic feet of air without creating coldness or draughts through a large cubic space per man than through a small one. If a room give only 300 cubic feet per man, its air has to be changed ten times in an hour to supply the 3,000 cubic feet of ven-

tilation. If it give 1,000 cubic feet per man, the air has to be changed only three times. A linear inflow of less than two feet per second is imperceptible. With two feet of current air the area of the inflow to deliver the 3,000 cubic feet would be 60 square inches.

The amount of carbonic acid in a sample of air is determined by adding a known quantity of lime or baryta water to the air in a large glass bottle or jar, and thereafter finding how much of the hydroxide has been converted into carbonate. The practical details are as follows:

Make an oxalic acid solution (2.864 per litre or $10-\frac{n}{10}$ oxalic acid + 12 Aq.), 1 c.c. of which is equivalent to 1 mgm. CO_2. Make also a caustic baryta or lime solution of equivalent strength. Transfer the alkaline solution for storage until required for use to small bottles each holding about 60 c.c. (two-ounce vials), each of which is corked securely and weighed, and the total weight of the bottle and its contents marked upon the label. The air to be examined is collected in a clean and perfectly dry glass bottle or narrow-mouthed jar, of known capacity. Ten-litre bottles are large enough to give accurate results. A small bellows with a rubber tube on its nozzle is conveniently used in filling the jar with the air to be examined, but care must be taken that the air entering by the valve of the bellows is not contaminated by any direct respiratory streams from individuals present. As soon as the change of air has been effected, one of the prepared baryta vials is uncorked and its contents poured into the jar, which is then closed by an accurately ground stopper, or preferably by a tightly fitting rubber cork. The baryta solution is then shaken in the jar, and made to flow all over its interior to promote its contact with the contained air; but to insure thorough absorption of the carbonic acid the jar is usually permitted to stand until the following day before determining the loss of alkalinity. Meanwhile the volume of the air operated on is ascertained from observations made at the time the air was collected. The height of the barometer and of the dry and wet bulb thermometers or the dew point must be known, as well as the quantity of bartya solution introduced into the jar. The last is obtained by weighing the now empty vial in which it was stored and deducting this weight from the gross weight marked on the label. The quantity in grammes of the baryta solution employed must be deducted as cubic centimetres from the known capacity of the jar. But in order that the experimental results may be susceptible of comparison, it is necessary to express the air volume in the space which it would occupy when dry at 0° Centigrade and under a pressure of 760 mm. of mercury. Increased pressure diminishes the volume of air, increased temperature expands it; and the pressure of the watery vapor present must also be taken into account. The temperature observations furnish the dew point, and through it, from the observations of Regnault, the pressure or tension of the aqueous vapor may be obtained. If p represents this pressure, t, the temperature in Centigrade degrees, b the barometric height in millimetres, and V the capacity of the jar, minus the number of cubic centimetres of baryta solution introduced, the corrected volume will be equal to

$$\frac{V\ (b-p)\ 273}{(273+t)\ 760}$$

If the observations have been made on Fahrenheit's scale and in barometric inches the formula is:

$$\frac{V\ (b-p)\ 491}{29.92\ (491+dt)}$$

in which dt is the number of degrees between 32° F. and the observed temperature.

When baryta solution is used to absorb the carbonic acid, the action may be considered completed in half an hour; but with lime water it is better to suspend further proceedings until next day. Then take, say, 20 c.c. from the jar, add phenolphthalein, and drop in the oxalic solution from a burette until the color is discharged. The loss of alkalinity in cubic centimetres = milligrams of CO_2 in the 20 c.c. of the solution tested, from which the CO_2 absorbed by the whole of the baryta solution may be calculated = milligrams of CO_2 in the air collected. Convert weight of CO_2 into volume by multiplying by 0.573, and for purposes of comparison calculate it into volumes per 10,000 of the corrected air. It must be mentioned, however, that the volume of carbonic acid found by this experiment is not all carbonic impurity, but includes that which is naturally present in the atmosphere. When the result of a contemporaneous experiment on the external air has been deducted from it, the remainder will indicate the carbonic impurity or the carbonic acid due to imperfect ventilation.

An easily applied method of ascertaining whether a given air contains more than a certain number of volumes of carbonic acid per ten thousand is based on the turbidity caused in lime water by the precipitated carbonate. If a half-ounce of this liquid is shaken up in an eight-ounce vial filled with the air to be examined, the appearance of turbidity indicates the presence of eight or more volumes of carbonic acid in ten thousand volumes of the air, and that the arrangements for ventilation in the apartments which furnished the air are not as satisfactory as could be wished. Bottles of various sizes are used by the operator conducting this, *the household method of sanitary air analysis*, and from the capacity of the bottle in which a just visible turbidity is produced the volumes of carbonic acid per ten thousand become known.

In another method, the *minimetric*, air is introduced in small quantity into a vial containing lime or baryta solution, which is well shaken, with gradual additions of the air, until the liquid shows a certain loss of transparency, when the carbonic acid is calculated from the quantity of air needful to the production of this result.

These, although pretty experiments, and described in full by most sanitary writers, have not come into general use, because they are not required. As they yield results which are only approximative, they cannot take the place of the accurate determination needful in a scientific inquiry, while, as rough-and-ready methods, their results convey no more information of practical value than may be gathered unpretentiously by the sense of smell. A well-ventilated room should not have more than one or two volumes per ten thousand in excess of the external air, equalling a total of five or six volumes. When the carbonic acid amounts to seven volumes, a want of freshness is recognized on entering. When nine, ten, or more volumes are present, the organic odor becomes manifest.

Although the carbonic acid, as has been stated, is generally accepted as a measure of the respiratory impurity, it is not an accurate one, for it is more readily diffused and carried off by ventilating current than the organic exhalations which accompany it from the human system. Whence it comes that the continued occupancy of an apartment may give rise to organic odors in its atmosphere, although carbonic acid may not be present in large quantity. The exhalation appears to adhere to walls and other surfaces, and textures, and to require time for its dissipation.

But, while the carbonic acid is not an accurate measure of the organic contamination in the air of occupied buildings, its estimation affords the best means of testing *the efficiency of the ventilation.* Sanitary inspectors do not recognize this fact. Sanitary chemists have not brought it prominently into notice. When questions of ventilation are to be settled, Cassela's air meter is used, and the air movement is calculated from its indications and the areas of inflow and exit. The inspector shows that so much air has entered or that so much has escaped, to be replaced of necessity by a corresponding volume of fresh air through the inflow ducts. But this is not enough. It must be shown that the air introduced has effected the purpose for which it was introduced. This may be done by a calculation based on the amount of carbonic impurity found by experiment. The capacity of the room must be ascertained, and in exact calculations deduction should be made for the body bulk of the occupants and for the furniture. The time during which the deterioration has been going on is another factor entering into the calculation.

The carbonic evolution, 0.01 cubic foot per minute or 0.6 per hour per person, multiplied by the number of minutes or hours, gives the amount of the carbonic impurity expired. When this is divided by the carbonic impurity found by experiment in ten thousand volumes of the air, the quotient multiplied by ten thousand will express, in cubic feet, the volume of the air with which the respiratory products have been diluted. But, as the air volume in the room has contributed to the dilution, its capacity has to be deducted from the total to obtain the amount of the inflow. Thus, if the data consist of 20 persons, 3 hours in a room having a capacity of 10,000 cubic feet, the air on analysis showing 14.5 volumes or a respiratory impurity of 11 volumes, as a parallel experiment on the external air indicates the presence of 3.5 volumes.

$.6 \times 20 \times 3 = 36$ cubic feet of carbonic acid expired.
$11 : 10{,}000 :: 36 : 32{,}727$ cubic feet of air concerned in the dilution.
$32{,}727 - 10{,}000$ in room $= 22{,}727$ inflow.
$22{,}727 \div 3 = 7{,}576$ cubic feet inflow per hour.
$7{,}576 \div 20 = 379$ cubic feet per hour per person.

In practice it is often found that the inflow, as determined by the anemometer, is much greater than that obtained from the chemical results. That the air enters is certain, and that it fails to be utilized in diluting the expired air is equally so. In one of the schools of Washington, D. C., 800 cubic feet per minute entered the room, while but 324 cubic feet contributed to the ventilation. The cause in this instance was manifest. The temperature of the inflow was so great that the air rose immediately to the ceiling, whence it was drawn off by the lowered windows and foul-air flues.

Impurities in Air.—Carbonic acid in air, while essential to vegetable life, must be regarded as an accidental impurity in its relations to animal life when present in any locality in excess of that found in the free atmosphere. The sources from which the carbonic acid is derived often yield with it other and more dangerous substances. These sources are, first, combustion for artificial warmth and lighting; second, the resolution or dissipation of dead organic matter, and, third, the resolution or dissipation of the tissues of living animals by the respiratory process.

Products of imperfect oxidation are associated with the carbon dioxide from the combustion of fuel. A lamp or fire smokes and smells when its oxygen or air supply is insufficient. The smoke is unoxidized carbon and the smell an emanation from transition products. The dangerous product in the combustion of fuel is carbon monoxide. This colorless and inodorous gas is highly poisonous, entering the blood and rendering the red corpuscles incapable of performing their functions even though pure air be afterward supplied. Death is the result of asphyxia. In rooms heated by stoves the headache, languor, and oppression occasionally produced are due to the escape of this with other gaseous products through the open stove doors, leaky joints, and turned dampers. Some experiments of St. Claire Deville and Troost indicated that the carbon monoxide might even pass through the pores of cast iron when the metal became strongly heated. The French Academy, therefore, caused an investigation to be made of this subject, and the conclusion was reached that this dangerous gas does pass through the metal when its temperature reaches a dark-red heat. Since these experiments, air heated by furnaces or cast-iron stoves has been regarded as injurious. But doubt has been thrown upon the results of the French chemists by several later experimenters, and particularly by Professor Remsen, who has shown some possible sources of error, and who, having guarded against these, has concluded that, while carbon monoxide may be present in the air of furnace-heated rooms, it must exist in quantities so minute that it is questionable if it can act injuriously on the health of those who breathe it.

The deadly nature of *water gas* as compared with coal gas is due to its larger proportion of carbon monoxide. Coal gas contains less than ten per cent., while water gas contains thirty to forty per cent. Water gas is manufactured by playing steam on glowing coke or charcoal, the products being carbon dioxide, carbon monoxide, and hydrogen. The number of deaths from leakage of gas has been greatly increased since the introduction of water gas. Where one death was formerly reported in a given time and population, there are now twenty-five to thirty deaths.

In connection with local accumulations of these gases it should be remembered that they are explosive when mixed with air. It is therefore dangerous to strike a light in the room of a gas suicide or to look for a gas leak in a cellar or basement until after some ventilation has been effected. A mixture of one gas to eight air is most violent in its explosion. With one to four there is not enough air for explosion, and with one to twelve there is not enough gas.

The evolution of carbonic acid into the air of a room during the combustion of illuminating gas or oil is generally underestimated in considering the carbonic impurity of occupied rooms. Parkes states that one cubic foot of gas consumed in an hour produces as much as the respiration of one person. One oil burner consuming four ounces of illuminating oil per hour is allowed in United States barracks for every ten soldiers. The oil consumed pervades the barrack room with somewhat more carbonic acid than is expired by the ten men. The necessity for increased ventilation must be considered with the presence of each lamp or gas jet.

Carbureted hydrogen and sulphurous acid are liberated during combustion, but in such small quantities that they need not be considered as affecting health.

Associated with the carbon dioxide derived from the oxidation of the carbon of dead and decomposing organic matters on the surface of the earth, sometimes aggregated locally into manure piles, cesspools, vaults, drains, and sewers, are certain compounds intermediate in composition between the complex organic matter in process of putrefaction and the simply constituted organic substances which are the result of the completed oxidation. The sulphur present in certain tissues becomes converted into hydrogen or ammonium sulphide, while among the nitrogenous products are many foul-smelling and harmful gases and vapors of an ammoniacal character; hydrocarbons also are formed. Formerly the reversion of organic matter to the inorganic condition was supposed to be due to the purely chemical process of oxidation by the oxygen of the air. Decomposition was regarded as a slow oxidation at a low temperature, as combustion was a rapid oxidation at a high temperature; but when Pasteur showed that meat could be preserved from putrefaction when exposed to the air, provided the air was first filtered through cotton wool, this chemical theory of decomposition had to be abandoned. Ultimately the saprophytic bacteria were discovered, and now these are recognized as so universally present and so essential to the disposal of organic matter that they cannot be regarded as an impurity in the air. They are the means to an end, one of the great links in the endless chain of life, and as important in the wonderful scheme of creation as the carbon dioxide which they prepare for the future growth of vegetation.

The action of the sulphur gases on the animal system has been demonstrated experimentally by Barker on dogs and other small animals. Hydrogen sulphide produces vomiting and diarrhœa, prostration and coma, which, like the effects of carbon monoxide, persist after removal from the contaminated atmosphere. The exhaustion and coma continue, and death results if the impression fixed on the blood is sufficiently powerful. But, while this occurred in the subjects of Dr. Barker's experiments, it is well known that men may breathe with

impunity for a time a sulphureted atmosphere many times stronger than those employed by him. Ammonium sulphide, according to this experimenter, caused vomiting and febrile action, quickly followed by the development of a typhoid condition. In fact, he considered the hydrogen sulphide similar in its action to the poison of typhus, and ammonium sulphide to that of typhoid fever.

Chronic poisoning by hydrogen sulphide manifests itself, according to some observations, by gradual prostration, emaciation, and anæmia, with headache, foul tongue, anorexia, and the occasional eruption of boils, but it is not certain that these symptoms are due to this gas and not to organic vapors which accompany it.

The action of the more *complex organic vapors* given off during decomposition has not been determined. The dogs subjected by Dr. Barker to cesspool air were all more or less affected, the symptoms being those of intestinal derangement with prostration, heat of surface, distaste for food, and those general signs which mark the milder forms of continued fever common to "the dirty and ill-ventilated homes of the lower classes of the community." But the sulphur compounds already mentioned contributed to these results.

Even the constitution of these organic vapors is not known with certainty. Dr. Odling distilled half a gallon of the liquid contents of a cesspool until all volatile matters had come over. He treated the fetid ammoniacal distillate with hydrochloric acid, and afterward precipitated with platinum. The platinochlorides of the organic alkalies were found to crystallize in well-defined, flattened, orange-colored tablets, evidently not the platinochloride of ammonium. Incineration of this platinum salt yielded 41.30 per cent. of the metal, while the platinochlorides of ammonium, methylamine, and ethylamine gave respectively, 44.36, 41.64, and 39.40 per cent. of platinum. The salt formed from the *carbo-ammoniacal vapors* was analogous in composition to that formed with methylamine. But inasmuch as the crystals were more like those of the ethyl salt, and as a mixture of the ethylamine and ammonium salts would correspond in percentage composition to that obtained from the distillate, he supposed that the sewage emanations were ammoniacal and ethylic.

A series of experiments made by the writer has shown that the volatile matters evolved during the fermentative changes in organic substances are of two different characters, the one vaporous and ethylic, but not containing nitrogen if separated from the ammonia with which it is volatilized and condensed, and the other volatile, carbonaceous, and solid, concreting on distillation into white, soft, and greasy particles. The former has a dull, mawkish, not positively unpleasant, odor, the latter a strong and intensely disagreeable smell.

Marsh gas, a colorless, inodorous, and, fortunately, non-poisonous gas, is largely formed as a transition product in the decomposition of vegetable matter. It is evolved in the gradual transformation of wood into coal, constituting in mines the "fire damp" which is the occasion of so many disastrous explosions. It explodes, in the presence of flame, when forming only one-eighteenth of the air of the mine. The resulting gases, carbon dioxide, nitrogen, and vapor of water, constitute the "after damp" or "choke damp" which suffocates those miners who have not been killed outright by the explosion.

Associated with the carbon dioxide of respiration are certain organic exhalations which differ in constitution, according to the efficiency or imperfection of the oxidation in the tissues. In diseased conditions of the body these exhalations are thrown out in greater quantity than in health and the infection of disease in some instances accompanies them. They are exhaled not only from the lungs, but also along with the perspiration from the pores of the skin. The quantity of organic matter thus eliminated has not been determined, but is known to be small. It does not diffuse like a gas into the atmosphere, but floats, when there are no currents to disturb it, like an odorous but invisible cloud. If evolved into the air of a close room its amount is proportioned to that of the carbon dioxide exhaled by the occupants, in the absence, of course, of any other output of this gas. As vapor of water is deposited from a saturated air, so these organic clouds become similarly condensed on walls, furniture, hangings, bedding, clothing, and other exposed articles. In a room saturated with organic exhalations the mere renewal of the air does not dissipate the taint, for the renewed air becomes immediately affected by the volatilization of the organic deposits. The necessity for a thorough aeration is obvious.

The evil effects of breathing respired air are attributed to these organic matters. Many experiments have been made on this subject, the most striking of which are those by Brown-Séquard and d'Arsonval, reported in 1889. They connected a series of four air-tight cages by means of rubber tubing and aspirated a steady current of air through them. In each cage was a rabbit. The animal in the last cage of the series breathed the air which contained the respiratory products of the animals in the other cages, while the animal in the first cage was supplied with pure air. After a time the animal in the last cage died as a result of its confinement in the impure air, and a few hours later that in the cage next to the last also succumbed. The inmates of the first and second cages survived. On placing an absorption tube between the third and fourth cages, the animal in the last cage survived the experiment, while that in the third cage died. This seemed to indicate that the toxic substance in the air was destroyed by the sulphuric acid and was therefore probably organic matter. These experiments were repeated, with the same results, by Merkel in 1892. In a Smithsonian contribution, however, by Drs. Billings and S. W. Mitchell, published in 1895, it is contended from some experiments made under their direction that in the air expired by healthy mice, rabbits, etc., there is no peculiar organic matter which is poisonous to the animals mentioned, or which tends to produce in them any special form of disease, and that it is very improbable that the minute quantity of organic matter contained in the air expired from human lungs has any deleterious influence upon persons who inhale it in ordinary rooms. They concluded also that the discomfort produced by crowded, ill-ventilated rooms in persons not accustomed to them is not due to excess of carbonic acid, nor to bacteria, nor in most cases to dusts of any kind, the two great causes of such discomfort being excessive temperature and unpleasant odors. These odors, it is said, may in part be due to volatile products of decomposition contained in the expired air of persons having decayed teeth, foul mouths, or certain disorders of the digestive apparatus, and they are due in part to volatile fatty acids given off with, or produced from, the excretions of the skin, and from clothing soiled with such excretions. They may produce nausea and other disagreeable sensations in specially susceptible persons, but most men soon become accustomed to them and cease to notice them, as they will do with regard to the odor of a smoking car or of a soap factory after they have been for some time in the place.

There are no micro-organisms in the air in the lungs. They are filtered out of the inspired air, or captured in mucus and ciliated out before they can reach the pulmonary cells. We know this to be the case because when there is no break in the skin in an injury to the lung from a fractured rib, we may have emphysema and pneumothorax with hemorrhage, but no pleurisy. Besides this, Tyndall showed by the electric beam the freedom of the expired air from particulate matter.

But that evil consequences do follow overcrowding and its necessarily vitiated air is well known. Every schoolboy knows the history of the Black Hole of Calcutta. The typhus fever which formerly ravaged the tenements of cities and the prisons, barracks, camps, and ships of all nations, is recognized as having been propagated by the noisome exhalations in unventilated and overcrowded quarters. Indeed, it may be said that not only has typhus fever been banished from civilized com