ON

CONTINUOUS MOLECULAR CHANGES,

MORE PARTICULARLY IN THEIR RELATION TO

EPIDEMIC DISEASES:

BEING THE

Oration

DELIVERED AT THE 80th ANNIVERSARY

OF THE

MEDICAL SOCIETY OF LONDON.

BY

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PREFACE.

THE title to these pages may, perhaps, seem rather obscure, on account of the various senses in which the word molecular has at different times been employed. I do not, however, know any better term by which to express all that refers to the attraction which exists amongst the particles of matter at insensible distances.

The word chemical is restricted to expressing what relates to the composition of bodies, and does not include properties, such as solidity and fluidity, which are called physical; nor some of the processes that we call vital, such as the formation of fibres and cells. It is especially desirable to have a general term to include what is understood by the words physical, chemical, and vital, in order to avoid the disputes respecting these two latter words, (disputes in which we see such authors as Humboldt, Liebig, and Alison engaged,) and the need-

less antagonism in which these words are sometimes placed towards each other.

All changes of composition whatever, whether occurring in a test-tube, or in the living brain, are properly included amongst chemical changes; and all that takes place in living structures has a right to be called vital, whether it differs from what occurs elsewhere or not. Thus, whilst the terms chemical and vital have each a separate signification, they have a certain ground in common, since changes of composition in living beings are at once both chemical and vital, and belong to both chemistry and physiology; just as fossil animals belong to both the mineral and animal kingdoms, and to the sciences of geology and zoology at the same time. To dispute whether the formation of urea or cholesterine is a chemical or vital process, is as useless as it would be to dispute whether a fossil ichthyosaurus is a mineral or an animal, and whether it belongs to geology or zoology.

I beg the reader to remember that the term oration proceeds from the laws of the Medical Society, and not from any claim of mine to be considered an orator.

18, Sackville Street:
March 26, 1853.

ON

CONTINUOUS MOLECULAR CHANGES.

The Medical Society of London having conferred on me the honour of electing me to deliver the oration for the present year, I have much pleasure in accepting the duty, and shall endeavour to perform it to the best of my ability. No restrictions are imposed by the Society with respect to the precise subject of the oration; but the nature of the appointment implies that the discourse should refer to the Society, or to the science which it is its object to cultivate. It is usually, and very properly, the custom on these occasions to treat of the past history, present state, and future prospects of the Society; but it is obviously not imperative that these matters should form the subject of every anniversary oration, especially as they are well known to the greater number of the Fellows.

It is my intention on the present occasion to make a few remarks on some of the chief phenomena of living beings.

The principal forces with which we are acquainted are, the attraction which the atoms of matter exert on each other at all distances, and the attraction which exists only at insensible distances. The first of these forces is called the attraction of gravitation; and the term chemical attraction, or chemical affinity, includes more or less of the second force, according to the more or less extended sense in which the word chemistry is understood. The effects of gravitation on living beings are of a simple kind, and are pretty well known; therefore they need not detain us. With respect, however, to the attraction which takes place at insensible distances, the case is different. The results of this attraction in living beings are very complicated and important, and they require much investigation.

The attraction of gravitation is a constantly operating force, even when it leads to no relative change of position; and in like manner the attraction at insensible distances is equally constant in its action under all circumstances, whether it is causing changes of composition and arrangement, or merely holding together the particles of a metal, or preventing changes in a compound body, by a balance of affinities. The attraction amongst adjoining particles of matter may be very feeble, but it is probably never altogether absent. Eminent chemists tell us, indeed, when speaking of atmospheric air, that "the nitrogen manifests no attraction for the oxygen," and that "all

bodies which have an affinity for oxygen abstract it from the atmosphere with as much facility as if the nitrogen was absent altogether."* But this is not quite correct. A red hot iron wire is incapable of abstracting oxygen from the atmosphere, although it combines very briskly with that gas in the absence of the nitrogen. A lighted candle, or a piece of ignited charcoal, has the power of abstracting only about one-fourth of the oxygen from a limited quantity of air, when the combustion ceases, whilst in the absence of the nitrogen it would consume nearly the whole of the oxygen. When animals are placed in an atmosphere made by mixing together equal parts of nitrogen gas and atmospheric air, and therefore containing just half the ordinary amount of oxygen, they exhibit more distress, and die much sooner, than in an atmosphere of the same extent, in which the oxygen and the nitrogen are both reduced to one half, by the air-pump.

It is evident, then, that the nitrogen of the air exerts an influence over the combination of oxygen with other bodies. This depends chiefly on the affinity between the nitrogen and the oxygen—an affinity which is not great enough to cause their combination under ordinary circumstances, but is sufficient to counterbalance, to a certain extent, the affinity between oxygen and other bodies. It is on this kind of counter-affinity, as it may be called, that the action of most narcotic

* Turner's Chemistry, by Liebig and Gregory, 8th ed. p. 206.

and antiseptic agents on living and dead animal substances depends.*

The phenomena of cohesion and crystallization shew that the attraction at insensible distances exists amongst the molecules or atoms of the same kind of matter, as well as of different kinds. There are other circumstances which illustrate the same principles. For instance, Professor Graham found that phosphorus is not acted on by pure oxygen, at the ordinary temperature and pressure of the atmosphere, but on diminishing the pressure or adding a little nitrogen the phosphorus begins to be oxidized.† The reason of this probably is that the attraction of the molecules of oxygen for each other prevents their union with the phosphorus, till this attraction is diminished by their increased distance. It is sometimes said that the particles of a gas have no attraction for each other, but are, on the contrary, mutually repulsive. The expansive power of gases depends, however, on the presence of heat. It bears a strict relation to the quantity of heat, and most substances exist either in the solid, the liquid, or the gaseous state, according to the temperature to which they are subjected.

A body that is falling, or sliding down hill, by the effect of gravitation, gathers force in its descent, and may

* See Med. Gaz. vol. xlviii. p. 1092; and Comptes Rendus, t. xxx. p. 52.

† Quarterly Journal of Science, 1829, Part II., p. 354.

communicate a similar motion to other bodies with which it comes in contact if they are ill supported. In like manner, one of the most striking phenomena of the attraction at insensible distances is, that the changes or actions to which it gives rise are often a cause of their own continuance and extension.* This is more especially the case in living beings, but obtains to a great extent in the most simple processes of combination and decomposition. Thus ordinary combustion, from whatever cause it may arise, will usually continue as long as there is a supply of fuel and of air. We can explain the cause of this by saying that the fresh materials become heated by the combustion to a certain degree of temperature which causes ignition. But in other molecular changes which contain the cause of their own propagation, such as the various kinds of fermentation and putrefaction,† we have no instrument, like the thermometer, with which we can measure the force that communicates the change to substances in contact with those in which it is taking place.

Combustion, putrefaction, and numerous other molecular actions, although capable of self propagation,

* See Liebig's Agricultural Chemistry, 2nd ed. p. 258.

† The self propagation of the process of decomposition in the urine is a subject of great importance in a medical and surgical point of view. See a paper on alkalescent urine and phosphatic urinary calculi, Med. Gaz. Nov. 20, 1846.

commence anew, under the requisite circumstances, without any contact with matter undergoing the same change. There are, however, changes of a more complicated nature—those to which plants and animals owe their development and continuance—that have never commenced anew within the experience of man. The most characteristic property, indeed, of vital actions probably is, that they are always caused by similar processes which have preceded them, whilst all other molecular changes may arise, occasionally at least, from other causes. A species of plant or animal consists, in fact, of a number or collection of continuous molecular actions. The process of change may, as in certain insects and plants, be suspended for a time on account of the deficiency of warmth, of moisture, or of oxygen, but, when it recommences, it is in precisely the materials in which it left off. The vital actions, in these instances, admit of a pause, but the continuity by contact of material is uninterrupted. To borrow an illustration from ancient mythology, it is as if there were a pause in the spinning of the thread of life without its being cut or broken.

The same kind of temporary suspension may occur in continuous changes which are not vital. For instance, if a seam of coal is on fire at a great depth from the surface, the combustion can be entirely arrested by cutting off the access of air; but, if no means are taken to cool the lately burning materials, they may remain

for months at a bright red heat, ready to enter again on the process of combustion should air be accidentally admitted.

In the seeds of plants, and the ova of many animals, the molecular changes are capable of being suspended, and of recommencing after an indefinite period; but they start again at the exact point at which they ceased, and should the matter of the seed or egg have deviated into any foreign change, such as putrefaction, it is incapable of continuing the process in which it had previously been taking part.

There is no distinct line of demarcation between vital processes and those which are not vital. Vinous fermentation, for instance, has been generally looked upon as a merely chemical change; yet it has great claims to be entitled a vital process. It is always accompanied by the formation of the cells or sporules of the yeast fungus—the decomposition of the sugar into alcohol and carbonic acid bearing a direct relation to the quantity of yeast produced.* Many persons would doubtless say that the formation of the sporules is a

* See Schleiden's Principles of Scientific Botany, translated by Dr. Lankester, p. 36; and Liebig's Agricultural Chemistry, 2nd ed. p. 282.

Schleiden is of opinion that the yeast cells originate without the influence of a living plant. If it be so, their formation may be looked on as a natural link between the non-vital and the vital—between ordinary chemistry and physiology. The words of Schleiden are: "At a certain temperature, which is perhaps

vital process, and the production of alcohol and carbonic acid a chemical process inseparable from it. According to this view, whilst cell development is undoubtedly a vital process,* digestion and the formation of compounds to be secreted or excreted are chemical processes. There is no objection to such a distribution of terms, but it must be remembered that the decomposition of sugar into alcohol and carbonic acid is as closely connected with a process of organization as are the sensibility and contractility of animal tissues. This blending together of what we call vital and what we

necessary to the chemical activity of the mucus, there originates, without as it appears the influence of a living plant, a process of cell-formation (the origin of the so-called fermentation fungus), and it appears that it is only the vegetation of these cells which produces the peculiar changes that occur in the fluid."

* Schleiden, however, speaking of vegetable cells, says,—"If further we regard the easy transformation of the assimilated matters, and may, from artificially conducted experiments, draw the conclusion that the nitrogenous matter which I have called mucus, and which forms the cytoblast, is the substance which calls forth these transformations; and if we further remark that sugar and dextrine are more easily soluble than jelly, and that sugar and gum are changed into jelly, if the quantity of water is not increased, and which must be necessarily precipitated, we must regard the whole process of cell-formation as simply a chemical act. The gathering together of granules of mucus to form a cytoblast we can as little explain as that, when we form a solution of two salts, if we throw into the mixture a crystal of one or other salt, that salt alone crystallizes around it."—Opus cit. p. 35.

call chemical, need not surprise us, however, when we consider that all changes of composition, with their attendant phenomena, whether taking place within the living body or not, are alike the result of the attraction or affinity which exists amongst the ultimate atoms or molecules of matter.

The quantity of matter in which any molecular change or group of changes is taking place, may diminish to a very small amount without the continuity of action being broken. A conflagration may diminish to a spark, and yet spread again to as great an extent as before. A species might diminish to one or two individuals without becoming extinct; and, at the point at which new individuals commence, the molecular actions are often confined to a minute quantity of substance. There is reason to believe, however, that this substance contains all the chief elementary and proximate principles of the mature being, as well as the power of communicating all those changes to suitable materials, by which they are assimilated, and made to form part of the individual. The ova of animals have seldom been subjected to analysis, but seeds are known generally to possess the medicinal principles of the plants to which they belong, in more regular quantity than other parts of the plant.

Procreation by sexes, which is the most usual mode of generation throughout both the vegetable and animal kingdoms, appears to have the effect of preventing deviations from the form and character of the

species; for gardeners are enabled, by means of cuttings, shoots, bulbs and tubers, to propagate many cultivated varieties of plants which differ greatly from the species to which they belong, and would soon revert to it if able and permitted to propagate by the sexual method, that is by seeds.

As organized beings rise in the scale of complexity, the points of connection between the individuals of one generation and those of the next increase in number and extent. In the lower classes of invertebrated animals a single germ yelk serves for the production of numerous individuals, and in some cases for the production of several generations; but in the higher invertebrata, and in all the classes of vertebrated animals, "only a single individual is propagated from each impregnated ovum."*

As we ascend through fishes and reptiles to birds, the number of the ova diminish and their relative size increases, till in some reptiles, and in all birds, the ovum, with its attendant yelk and albumen, is sufficient for the development of a nearly perfect animal, which undergoes all its metamorphoses before it has escaped from the shell, or obtained any nourishment beyond that contained in the egg.

In the class mammalia, with the exception of the marsupial order, the embryo becomes rooted, by means of the placenta, in the uterus of its mother, from whom

* Owen on Parthenogenesis, p. 62.

it thus derives the materials for its development and growth, up to the period of its birth. The young of all mammiferous animals are also supplied by the mother, for a considerable period after birth, with nourishment secreted from her own blood; and medical men have ample experience, as regards their own species, how much the prospect of health and life is diminished by the deprivation of this natural supply of nutriment.

In many birds and mammals there is a further connection between one generation and the next, in the way of teaching the young, to a limited extent, how to procure food and escape danger. In the human species, enjoying the faculty of speech, this connection between succeeding generations is much more intimate. Even among the Indians the boy is made to imitate all the actions of the man; and in civilized countries, education, aided by literature, is generally much more complex and prolonged. In our own profession it has been truly said to last to the end of life, and institutions like this Society have the effect, not only of preserving and transmitting the knowledge of one generation of medical men to the next, but of increasing the boundaries of the science they cultivate, and rendering it more perfect and useful.

The communication of certain molecular changes taking place in the brain is by no means confined to the connection between parents and offspring, but extends collaterally in all directions, by means of vibrations in the air, or in the ethereal medium which pervades space.

If the brain of an animal is in a particular state of molecular action, from any object that excites fear or joy, it may cause a similar state of the brain in others of its species, by uttering a cry, or merely assuming a particular demeanour. The faculty of speech gives to man a power of communicating his complex feelings and ideas, far exceeding that of the lower animals; and the invention of literature has greatly increased this power in civilized nations. By speech, not only can fresh sensations and ideas be communicated, but also that continuation of them called remembrance, by which they revive after, it may be, a long interval of suspended action. By the aid of literature, indeed, knowledge committed to writing may lie dormant for centuries, like the ears of wheat in the hand of the Egyptian mummy, and then again take up the process of growth, to increase and spread in another part of the world.

In addition to the series of continuous molecular changes having for their result the preservation of the individual and the species, there are others, occurring in living beings, which have an opposite tendency; they divert part of the substance of the individual from the actions which are natural to the species to another kind of action, in consequence of which this substance is employed in the multiplication and increase of the materies morbi of communicable diseases—an extensive group of maladies, each case of which is caused by

some material that, as a general rule, has been produced in the system of another individual. The origin of these diseases, for aught we can tell, may be as remote as that of the beings they infest and exist on.

The communicable diseases—I use this term in preference to contagious, for various reasons*—the communicable diseases, to which the human species is liable, are chiefly as follow : — syphilis, small-pox, measles, scarlet-fever, typhus, typhoid and relapsing fevers, erysipelas, yellow-fever, plague, cholera, dysentery, influenza, hooping-cough, mumps, scabies, and the entozoa. Some persons do not admit the whole of the above diseases to be communicable, and, on the other hand, the Registrar-General includes acute rheumatism, and scurvy, in his class of zymotic diseases, although there is no evidence that these complaints are communicable. However, we have not been informed by the Registrar-General or Mr. Farr whether they wish the term zymotic to be understood in its true sense, which, as referring to diseases, signifies that they are communicable or contagious; for yeast and other fermenting materials communicate, to substances capable

* The word contagious is employed in a very different manner by different authors, and it could scarcely be employed, if any regard were paid to its etymology, to express some of the indirect modes of the communication of disease alluded to in the following pages.

of undergoing fermentation, a state of change similar to that by which they themselves have been produced.

The material cause of every communicable disease resembles a species of living being in this, that both one and the other depend on, and in fact consist of, a series of continuous molecular changes, occurring in suitable materials. The organized matter, as we must presume it to be, which induces the symptoms of a communicated disease, except in the case of the entozoa, can hardly ever be separately distinguished, like the individuals of a species of plant or animal; but we know that this organized matter possesses one great characteristic of plants and animals—that of increasing and multiplying its own kind.* In the instances of syphilis, small-pox, and vaccinia, we have physical proof of this increase, and in other diseases the evidence is not less conclusive.

The molecular changes taking place in the materies morbi of some diseases resemble the changes in many living beings in another respect also: they permit of being suspended, under certain circumstances, and recommence at the point at which they ceased. Thus the matter of variola and of vaccinia can be carried, in the dry state, to distant parts of the world without injury, like the seeds of a plant.

* See a paper by Mr. Grove, of Wandsworth, Med. Times, vol. xxiv. p. 640.

No evident effects are produced at first by the reception of the material cause of any of these diseases. There is always a definite period, of longer or shorter duration, before the illness commences, which is called the period of incubation. As regards the materies morbi itself, this a period of something more than incubation; it is a period of reproduction. All substances capable of causing a disturbance in the animal functions produce symptoms from the moment of their absorption or imbibition, when introduced in sufficient quantity; but the specific animal poisons, as they are called, are very rarely, if ever, introduced in such quantity as to produce sensible effects; the disturbance in the system, which constitutes the diseases they induce, being due to the crop or progeny of the matter first introduced.

One character of communicable diseases is, that they are apt to be extremely prevalent at particular times and places. This character, which arises strictly out of their communication from individual to individual, has obtained for many of these diseases the name of epidemics—a name which may be applied to nearly all of them, although some are prevented, under ordinary circumstances, from showing their epidemic character. Thus syphilis, for instance, keeps a pretty even course in this metropolis, because there is a steady amount of vice for its support, and a still greater amount of virtue to keep it in check; but when it is introduced amongst a community of savages, indulging in promiscuous intercourse, it rages as a fearful epidemic. The extent

of population and of intercourse has great influence over the epidemic character of communicable diseases. The various irruptive fevers are constantly present in London, and are only liable to fluctuations in their prevalence. In less populous districts, however, there are not enough subjects to support their constant presence. One or other of them is often absent for a number of years, and, when re-introduced, spreads to a great extent. There is one disease which neither the metropolis, nor the country at large, nor even the whole of Europe, will supply with victims except for a time. The cholera has been twice spread over the world within the memory of the present generation, and seems to be dying out a second time everywhere but in the south of Asia. Fatal as it is to the human species, it is itself so difficult of support that the world seems scarcely large enough for it, and, were it not for its pasture in India, it would be in danger of passing altogether out of existence, like the dodo of the Mauritius.

So far as can be learnt from what remains of ancient medical literature, the communication of diseases was not generally recognised till a recent period. Even Sydenham did not recognise the communicability of any acute febrile disease except the plague. He did not even recognise the communicability of small-pox. Sydenham, however, was fully aware of the resemblance between the material cause of an epidemic disease and a species of animal or plant, but he was not aware that animals and plants proceed only

from procreation by their own kind; and this is probably the reason why the communication of most diseases was unknown to him. Natural history was but little cultivated in his day; and he thought that plants, some of them not of the lowest classes, could be produced by other causes than generation. In the preface to the History and Cure of Acute Diseases, he says:—"Every specific disease arises from some specific exaltation, or peculiar quality of some humour contained in a living body." And again:—"For as every plant or animal is possessed of peculiar properties, so is it likewise in every exaltation of any humour after its being come to a species or disease. We have a clear proof of this every day," he continues, "in those kinds of excrescences that grow on trees and shrubs (occasioned by the ill quality of the nutritious juice, or other causes), in the form of moss, mistletoe, mushrooms, and the like, all of which are manifestly different essences, or species from the tree or shrub that bears them."

For want of knowing any other cause, epidemics were attributed, by the ancients, to the atmosphere, without any evidence; just as political and social events were believed to be occasioned by the stars. Now as people are not only exposed to the atmosphere, as soldiers in battle are to bullets, but are actually immersed in it, as fishes are in the sea, it became necessary to explain why certain persons were attacked and others not attacked, and the word predisposition

was used as affording an explanation. The alleged predisposition, however, was nothing visible or evident: like the elephant, which supports the world, according to Hindoo mythology, it was merely invented to remove a difficulty.

As the composition and physical properties of the air began to be better understood, it became evident that the atmospheric hypothesis of epidemics did not explain their phenomena, even with the assumption of a predisposition existing in some persons and not in others. It is not possible, for instance, that a disease caused by anything in the general atmosphere should progress in opposition to the wind, or should remain for weeks in a place before extending to the next parish on either side. There are still, however, some persons, especially amongst the general public, who lean towards the atmospheric origin of epidemic diseases; and, when Professor Schönbein lately considered that he had discovered a new gaseous substance in the air, which he named ozone, it was straightway supposed that this was the cause of cholera. After a little time, as the supposed ozone was found to be pretty generally present, cholera and some other diseases were attributed to its absence. Of course either the presence or absence of azone, along with a presumed predisposition, would afford a perfectly satisfactory explanation of cholera, or any other disease, to all those who do not require any proof.

It is quite possible, and, indeed, almost certain, that

the material cause of some communicable diseases may be wafted a short distance through the air, like the seeds and spores of many plants. The matter of small-pox pustules, for example, retains its powers after being dried, and may be shaken from articles of clothing, and thus wafted through the air. This is probably true of other diseases. It is, however, only a mode of communication of the disorders in question, and would not warrant us in speaking of their atmospheric origin, any more than of the atmospheric origin of plants.

When the communication of diseases began to be recognised, it was thought to depend, in most cases, on effluvia given off from the patient into the surrounding air: even syphilis, for some time after its appearance in Europe, was believed to be propagated in this way, and persons suffering from it were driven out of the towns and villages to live or die in the fields, lest they should infect others with their breath, although the disease was not attributed to any misconduct on their part.* Now as effluvia of any kind must reach all who approach the patient, the idea of a predisposition existing in some persons and not in others, has been retained to explain why certain individuals only are attacked with the diseases. We are informed by M. Ricord and others that when the pus from a chancre, in its active or increasing stage, is introduced

* Astruc, lib. i. ch. iv.

by inoculation, it never fails to communicate the disease. The matter of small-pox pustules hardly ever failed, when inoculation was practised, to cause the complaint in those who had not had it already; and vaccination does not fail more than once in several hundred times, when properly performed. So far, therefore, as we have analogy to guide us, we are warranted in concluding that when the morbid matter of any disease is received into the system, in the way required in that particular disease, it is almost certain to produce its specific effects, except in the instances in which the patient has gained an immunity by a former attack. Consequently, until it can be shown that the materies morbi of any communicable disease has really entered the economy of those who do not take the malady, there is no reason to invoke a supposed predisposition, or predisposing causes, to account for its existence in the persons in whom we find it. To be of the human species, and to receive the morbid poison in a suitable manner, is most likely all that is required.*

Climate and season have a certain effect in favouring or preventing many epidemic diseases. Yellow

* I do not deny that the period of life, being ill or well nourished, and other evident conditions of the patient, influence his liability to certain epidemic diseases. The predisposition objected to above is that which is assumed, without any symptoms of its existence, merely from the fact of the patient taking the disease.

fever has not yet been known to propagate itself to any extent in high latitudes. The plague, when it visited countries with a temperate climate, prevailed chiefly in the summer, and this has also been the general rule with Asiatic cholera, although, at Moscow and in Scotland, it has been most severe in the winter, on both occasions of its visiting Europe. The influence of climate and season have, however, been much over-estimated, having been even accused of causing epidemics. We constantly, also, hear climates called healthy or unhealthy; which is as incorrect as it would be to call them fruitful or barren. California, for instance, was proverbial for the healthiness of those who resided there, and this healthiness was attributed to its climate. No sooner, however, was the discovery of gold made, than the cholera was conveyed across the mountains, by crowds of people, who left the route strewed with the dead bodies of those who died on the journey. Dysentery and other diseases began to prevail amongst the diggers, and the medical men found plenty of employment; although it cannot be supposed that a few hundred people, scratching here and there for gold, had altered the climate of the country.

Certain localities are favourable to the communication of particular epidemic diseases, whilst others are unfavourable; for instance, in this metropolis, the low-lying districts on the south of the Thames have proved more favourable to the propagation of plague and cholera than the more elevated districts on the north. .

Yellow fever and dysentery are also most prevalent in the low and marshy parts of hot countries. Such situations are sometimes said to be productive of diseases; but this expression is obviously incorrect, when applied to those disorders which are communicable from person to person, either directly or indirectly.

There is one class of diseases—intermittent fevers—which are so fixed to particular places that they have deservedly obtained the name of endemics. They spread occasionally, however, much beyond their ordinary localities, and become epidemic. Intermittent fevers are undoubtedly often connected with a marshy state of the soil; for draining the land frequently causes their disappearance. They sometimes, however, exist as endemics, where there is no marshy land or stagnant water within scores of miles. Towards the end of the seventeenth century, intermittent fevers were, for the first time, attributed by Lancisi to noxious effluvia arising from marshes. These supposed effluvia, or marsh miasmata, as they were afterwards called, were thought to arise from decomposing vegetable and animal matter; but, as intermittent fevers have prevailed in many places where there was no decomposing vegetable or animal matter, this opinion has been given up in a great measure; still the belief in miasmata or malaria of some kind, as a cause of intermittents, is very general. It must be acknowledged, however, that there is no direct proof of the

existence of malaria or miasmata, much less of their nature. Intermittent fevers were attributed to such agents from the absence of any other known cause, especially as they were observed to come on after exposure to the air of certain localities, more particularly at night.

There is, however, some evidence of another and different cause of intermittent fevers than that above alluded to. In the "General Report of the Poor Law Commissioners on the Sanitary Condition of Great Britain,"* Mr. Wm. Blower, Surgeon, of Bedford, states that typhus and ague, which had long infested the village of Wootton, near Bedford, had been much diminished by digging a few wells, and obtaining good water. He also states that, in the neighbouring parish of Houghton, almost the only family which escaped ague, at one time, was that of a respectable farmer who used well water, whilst all the other families had only ditch water.

M. Boudin† relates a very marked instance in which intermittent, and apparently also remittent, fever were caused by drinking marsh water. It is as follows:—

"In July, 1834, 800 soldiers, all in good health, embarked on the same day in three transports at Bona, in Algeria, and arrived together at Marseilles; they were exposed to the same atmospheric influences, and were, with one essential difference, supplied with the

* 8vo. 1842, p. 66.

† Essai de Géographie Médicale, p. 53.

same food, and subjected to the same discipline. On board one of the vessels were 120 soldiers: of these, 13 died on the passage, from a destructive fever, and 98 more were taken to the military hospital of the lazaretto at Marseilles, presenting all the pathological characters proper to marshy localities. On seeing the physiognomy of these patients, altogether so unusual for Marseilles, one would have said that the Gulf of Mexico, the Delta of the Ganges, and the marshes of Senegal and of Holland, had supplied passengers to this ship. In short, by the side of a simple intermittent, there was a pernicious fever. On an inquiry being instituted, it was ascertained that on board the affected ship the water supplied for the soldiers, owing to the haste of the embarkation, had been taken from a marshy place near Bona; whilst the crew, not one of whom was attacked, were supplied with wholesome water. It further appeared that the nine soldiers who escaped had purchased water of the crew, and had consequently not drunk the marshy water. Not a single soldier or sailor of the other two transports, who were supplied with pure water, suffered."

Mr. Grainger, who quotes the above circumstance in his Appendix to the Report on Cholera, also says,* "Dr. Evans, of Bedford, related to me an equally well-marked instance. A few years ago, he was staying at Versailles, with his lady, when they both became affected with the ague, and, on inquiry, the following

* Page 94.

facts were disclosed. The town of Versailles is supplied with water for domestic purposes from the Seine, at Marli. At the time in question, a large tank, supplying one particular quarter, was damaged, and the mayor, without consulting the medical authorities, provided a supply of water, consisting of the surface-drainage of the surrounding country, which is of a marshy character. The regular inhabitants would not use this polluted water; but Dr. and Mrs. Evans, who were at an hotel, drank of it unwittingly, and it was also used by a regiment of cavalry. The result was, that those who drank the water suffered from intermittent fever of so severe a type, that seven or eight of the soldiers, fine young men, died on one day, September 1, 1845. On a careful investigation it was ascertained that those only of the troops who had drunk the marsh-water were attacked; all the others, though breathing the same atmosphere, having escaped, as did also the townspeople."

In all the instances I have just quoted, the cause of ague, whatever it may be, was swallowed with the water, not inhaled with the air; and on questioning two patients, ill with this complaint, in St. George's Hospital, after harvesting in Kent, they told me that they had often been obliged to drink water from the ditches. The disease of the liver and spleen, to which persons are subject after attacks of intermittent fever, also confirms the view that its material cause enters the system by the alimentary canal, and not by the lungs;

and it is of importance to remark, that Hippocrates observed, that drinking stagnating waters caused hard swellings of the spleen.*

Whether the unknown cause of ague has been produced in the system of a previous patient, like the pus of small-pox and the eggs of tape-worm, or whether it has been produced externally, there is, at present, no sufficient evidence to show. In the case first supposed, the disease would be a communicable one, in the second it would not.

There is one circumstance which seems to indicate that the specific cause of intermittent fevers undergoes a development or multiplication within the system of the patient,—it is, that a period of dormancy, or incubation, has been observed, in many cases, between the visit to the unhealthy locality and the illness which followed; for, as I have already remarked, every poisonous or injurious substance causes symptoms as soon as it has been absorbed in sufficient quantity.

The communication of ague from person to person has not been observed, neither has that of tape-worm, although in this latter disease there is proof of communication that hardly any one disputes, viz. the evidence that the creature is only found in the bowels, and the general principle, "omne vivum ex ovo." Supposing ague to be communicable, it may be so only indirectly, for the materies morbi eliminated from one patient may require to undergo a process of develop-

* De aere, aquis et locis.

ment or procreation out of the body before it enters another patient, like certain flukes infesting some of the lower animals, and procreating by alternate generations.

But, to return to those diseases which are known to be communicable, there are certain spots, more limited than the districts or localities previously mentioned, in which they find easy means of communication :—I allude to the courts and allies crowded with the poor. It happens that there is generally no lack of offensive gases or disagreeable smells in these spots. Now it is well known that the gases arising from decomposition cause no fevers or other epidemic diseases, when they are made artificially in the laboratory. The same is true when they occur more naturally in the dissecting room ; and it has also been proved that persons who get their living by working amongst decaying animal and vegetable matters are not more liable to these diseases than other persons.* Still there are some medical men, and a benevolent section of the general public, who attribute the excess of epidemic disease, found in crowded and poor localities, to what are called noxious effluvia. They cannot say that these effluvia predispose to the diseases, for persons from the country are often attacked too soon after their arrival in such places to allow of this mode of action, and they do not inquire whether peculiar facilities may not exist for the conveyance of specific virus from one person to

* See Bancroft on Yellow Fever.

another, but they hold that the noxious effluvia, together, perhaps, with an undefined something in the general atmosphere, may cause or increase any epidemic disease whatever; and, when a nuisance is discovered, the prevalence of any kind of disease at the place is said to be explained, although we are not told how. The gentlemen who hold these popular opinions do not seem to recognise specific causes of disease. They are, with respect to diseases, in the position that some of our ancestors were in with respect to plants and animals, when they believed in spontaneous or equivocal generation, and thought that dirt engendered vermin, and that mushrooms arose from horse-dung.

Nothing assists the communication of disease more than the want of personal cleanliness. This has been particularly observed in regard to plague, cholera, yellow fever, and continued fevers. There is one class of people who have no provision for cleanliness whatever—namely, the vagrants,—and they are notorious for contracting fevers, and carrying them about from place to place. It is the same with regard to cholera, when that disease prevails; and these people nearly always have the itch. Amongst the poor, who are less unfortunately situated, there is often very little cleanliness, and, when a number of persons reside, sleep, and eat in a small room, in which also the cooking is conducted, it is extremely difficult, when an individual is confined to bed by illness, to prevent his excretions being partaken of by all the inmates; indeed, with

the uncleanly habits of many of the poor, this is altogether impossible. Under these circumstances we find that, when typhoid fever or cholera enters such a dwelling, it is very apt to go through the house, as the phrase is. It often attacks the friends also, who visit and eat and drink with the inmates, whilst the medical and clerical visitors escape. But when cholera or typhoid fever occurs in cleanly families, where the nursing, the cooking, the sleeping, and the eating go on in separate apartments, it is hardly ever found to spread.

It is not improbable that the specific cause of influenza and measles is drawn in with the breath, as these diseases affect chiefly the respiratory organs, and spread almost equally amongst all classes of the community; but the great aid that want of personal cleanliness lends to the extension of many communicable diseases points to another mode of communication; namely, that by swallowing the morbid material. It has been said that animal poisons do not act when taken into the stomach; but this is incorrect, for cantharides, the sausage and bacon poisons, and others, act when taken in this manner; and it should also be remembered that the virus of a specific disease is not strictly a poison, in the sense of that of the viper, for it is capable and requires to be multiplied in the system, before its effects appear.

There is evidence tending to show that typhoid fever, yellow fever, and plague, as well as cholera, are

communicated by accidentally swallowing the morbid excretions of the patients, and that these latter may sometimes be conveyed to a distance with the drinking water, or other articles of diet, without losing their specific properties.* Thus the communication of these diseases may be more or less direct or indirect, even when it takes place virtually in the same manner. The first authenticated case of cholera which occurred in London in the autumn of 1848, was that of John Harnold, a seaman of the steam ship Elbe, newly arrived from Hamburgh, where the disease was prevailing. He died in a lodging at Horsleydown, near the river. The next case was that of a man who came to lodge in the same room; and a few hours afterwards cases occurred in Lower Fore Street, Lambeth, and in White Hart Court, Chelsea, amongst people who had no water for drinking or any other purpose, except what was obtained by dipping a pail into the Thames. Thus the cholera poison from John Harnold appeared to be distributed like the seeds of a river-side plant, some of which germinate and grow up by the side of their parent, whilst others are conveyed some distance

* Dr. Jenner lately called my attention to an instance occurring at the village of North Boston, Erie County, N. Y., in which typhoid fever was probably communicated to a number of families by the contamination of the water of a well which they used. See Clinical Reports of Continued Fever, by Austin Flint, M.D., Buffalo, 1852, p. 380; also, Med. Times and Gazette, March 12, 1853, p. 261.

by the tide, and take root on another part of the shore.

Those sudden extensions of cholera, which are called outbreaks, were in many cases due to the mixture of the cholera-evacuations with the water used for drinking and preparing food. This was shown to be the case in the Wandsworth Road, in Bermondsey, and in Rotherhithe, during the summer of 1849.* It has been often argued that sudden outbreaks of cholera are incompatible with its propagation from person to person, but we know of no circumstances to restrict the number of persons who may receive the disease from one or two patients, under favourable circumstances for the distribution of the morbid matter. There were a few cases of cholera present at Kurrachee, previous to the outbreak of the disease in 1846, which has been often alluded to; so that, like the outbreaks in England, it was in reality but an extension of the malady.†

Medical men are naturally apt to form their opinions

* Snow on the Mode of Communication of Cholera, p. 12; Med. Gaz. vol. xliv., p. 747; Med. Times, vol. xxiv., p. 561.

† The following table from p. 2 of Mr. Alex. Thom's Report of the Cholera at Kurrachee shows the progress of the outbreak:—

Dates.	Admissions.	Deaths.
June 11	1	1
„ 12	2	—
„ 13	2	—
„ 14	1	1
„ 15	47	8
„ 16	105	70
„ 17	104	53
„ 18	47	32

respecting the communication of diseases from their own experience, rather than from the general history of the maladies, and thus they believe in its contagion, when a disease, such as cholera or typhoid fever, generally spreads directly from person to person in their practice; but in districts or connections in which the indirect and less obvious mode of contracting disease is, from physical causes, the previling one, they are apt to become what are called non-contagionists.

It may very fairly be asked whether communicable diseases do not sometimes arise spontaneously—that is, from other causes than their communication, just as ordinary combustion, putrefaction, and some other continuous molecular changes, very often commence anew, from various causes, without any continuity with previous changes of the same kind, and it is not improbable that some communicable diseases may arise, so to say, spontaneously. The erysipelatous inflammation, for instance, which attacks the neighbourhood of wounds, probably arises now and then without being communicated; otherwise we must suppose the material which causes it to be almost as widely diffused as the spores of some of the fungi. There is, however, great reason to believe that the larger number of communicable diseases never arise from any other cause than the communication of the specific virus from a previous patient. Dr. Watson has given very strong proofs of this, in regard to small-pox, in his lectures, and proofs almost as strong might be adduced in respect to other

diseases. We know very well from history that the plague spreads fearfully in this country, when it is imported, and, if it ever arises spontaneously, why should we have been without a case of it for nearly two centuries? We sometimes hear it asked, "Then how did the first case arise?" The question might as well be asked with respect to the first tiger or the first upas tree; but our ignorance of the first origin of natural phenomena need be no obstacle to the investigation of their present causes.

I have just said that some communicable diseases, such as erysipelatous inflammation, may possibly arise, now and then, without contagion; but there is an opinion held by some men of eminence to which it is very difficult to assent:—I allude to the doctrine that a disease caused by malaria, which is supposed to be produced out of doors, without any regard to a previous patient—that such a disease can, under certain circumstances, take on contagious properties. For instance, many persons believe that yellow fever, as it occurs, for example, on the western coast of Africa, is caused by malaria or marsh miasmata; and when they have been convinced by such facts as those adduced by Dr. M'William respecting Boa Vista, that this fever is communicated from person to person at another place, instead of reviewing their previous opinion, they try to reconcile it with the new conviction, by supposing that the disease has taken on contagious properties which

it did not previously possess. Now this amounts to nothing more or less than supposing that some material produced in marshy ground, without any connection with the human body, can be reproduced and grow in the system of the patient. I believe we know nothing in nature analogous to this, and it is therefore an opinion which should not be adopted till there is strong evidence in its support. It is most likely that yellow fever was always a communicable disease.

With respect to preventing the communication of disease, it is worthy of remark that there are two diseases whose mode of propagation is well known to almost everybody, and almost everybody has it in his power to avoid them—I allude to syphilis and the itch. It will perhaps one day be seen whether other communicable diseases may not be as easily avoided, when their mode of communication is known. In the meantime it is very well ascertained that cleanliness is a great protection against many of them, as are also space, daylight, and ventilation. The cleanliness which, it may be observed, cannot be attained without sufficient space and daylight, should not be a cleanliness for mere appearances; it should be a rational cleanliness, like that by which the chemist keeps his tests pure and distinct, and the farmer his land free from weeds. There should be not only personal cleanliness, but cleanliness in every department of the household—cleanliness in builders and owners of house property, to deter them

from sinking wells so near to cesspools and drains, that their contents may percolate without proper filtration —cleanliness in water companies, to prevent them from sending water containing sewage to their customers, as was done on the south side of the Thames till very lately—and cleanliness in sanitary reformers, to deter them, in their fear of offensive effluvia, from abolishing cesspools and having the sewers flushed, and thus sending all the recent excrementitious matters into the rivers, until they have ascertained that people are no longer obliged to drink the water of these rivers.

Some great improvements have been made lately in the way of cleanliness. The model lodging-houses are instances of this kind, and so are the public wash-houses, which enable poor persons to wash the foul linen of a sick person without being obliged to do it amidst the plates and tea-cups, the bread and meat, and other provisions of the family.

The prevention of epidemic or communicable diseases is a subject which deserves increased investigation. These diseases influence the life, the death, and the numbers of the human race, more than all other causes. The very learned physician Dr. Gordon Latham is of opinion that the downfall of the Roman Empire was due as much to several severe epidemics as to any any other cause; and although I am far from apprehending any such calamity now, as "a speedy return of the middle ages," there are circumstances occurring

which deserve our vigilance. The increased and more rapid traffic between nearly all parts of the world, especially that by means of large steam-ships, renders it probable that diseases, hitherto confined to particular divisions of the globe, may gain a wider range, and thus increase the number of diseases in nearly every country. For now, when the commercial interest and influence preponderate over every other, the day is gone by for strict quarantine, which, indeed, was ever but a doubtful measure, as it was liable to evasion, and could not be enforced on the smuggler.

The question of contagion in various diseases has often been discussed with a degree of acrimony that is unusual in medical or other scientific inquiries. The cause of the warmth of feeling that has been displayed has, in most cases, probably been unknown to the disputants. It is the great pecuniary interests involved in the question, on account of its connection with quarantine. In the preface to his work on the Plague of Aleppo, Dr. Russell says,—

"But however indisputable the fact of the plague being contagious may be deemed by modern physicians, it may be remarked that it has been strongly opposed, as often as the subject of quarantine has fallen under the deliberation of the legislature; and the public, at such times, have been constantly pestered by an inundation of pamphlets, which, without advancing anything

new, merely retailed arguments which had long before been refuted."

Since 1791, when the above was written, the commerce of this country has increased a hundred-fold, and for every ten thousand pounds that were jeopardised by quarantine then, a million is in danger now.

The chief arguments against the communication of disease have been shaped according to the belief that, if communicated at all, it must be by contact with the patient, or by effluvia from his person, clothing, or bedding. The communication of disease by accidentally swallowing morbid excretions, to which attention has more particularly been called of late, considerably alters the ground of debate; but if the doctrine of the communication of disease must involve quarantine, it will always be very unpopular, and its advocacy extremely unpleasant to the medical man, however conclusive the proofs of it may be. This of itself is a reason for endeavouring to ascertain how far communicable diseases of all kinds can be prevented by measures of detail which do not interfere with commerce.

The mode of propagation and the means of prevention of epidemic diseases require, as I said, increased investigation; and if any inducements were wanted to stimulate my present audience to that inquiry, it would only be necessary to remind you that, by investigating one of these diseases, a former

Fellow of this Society was enabled to make the greatest discovery that has ever been made in the practice of medicine, and to render the greatest benefit to his species which they have probably ever received. I need hardly say that I refer to Jenner.

THE END.

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