a year; and if its use became general, the saving in fuel, materials, and labour, would amount to the enormous sum of £1,000,000 annually.

At the Ystalyfera works the escaped gas is made serviceable in the conversion of pig into malleable iron; and Mr. Budd considers it extremely probable that the fuel consumed in the blast furnaces will eventually be made available for all the other purposes of the works.

A brief discussion of a practical nature followed, in which the Chairman, Mr. West, Mr. Ward, and another gentleman took part.

The next Paper read was—

ON MALARIA AND DISINFECTANTS. BY JAMES HAYWOOD, ESQ., OF SHEFFIELD.

In applying the science of Chemistry to the explanation of the various natural phenomena with which we are surrounded,—in endeavouring to trace the manifestation of its changes in vegetable and animal life, and to discover the intricate decompositions which accompany these changes under the direction of vitality, is a task which has been left for modern chemists to prosecute and accomplish; and although the great cause by which these changes are effected is at present entirely hid from our comprehension, we have been able to acquire such an amount of knowledge of the effects, that we can now explain many of those vital transformations with a degree of certainty which cannot admit of a doubt. The chemical changes which take place in the stomach during digestion—many of those which occur in the blood during its passage through the system—the constant decomposition and re-formation of organised tissue in the body—is no longer a matter of speculation. The balance has even
been applied in vital processes; and although it would appear at first sight almost incredible, we can now state positively to a few grains weight how much tissue is decomposed in a given time, and how much of the various kinds of food is required to restore it. With this amount of knowledge of the causes which pertain to the healthy existence of animal life, we have been led to investigate, and ultimately to comprehend, others of a more complex nature which influence its existence. The action of various foreign ingredients in the system, like the application of re-agents in analysis, were found to exercise a certain influence on the various compounds in the system, and to modify the changes on which a healthy action mainly depend. It is true that the action of many substances still remains a mystery; but from having perfectly made out the modus operandi of some, we may hope soon to discover that of the rest. The chemical change of organized tissue by the action of a corrosive poison, the chemical action of ammonia, alcohol, and other stimulants, and the influence of many organic salts, are all traceable to certain well-known affinities which these matters possess for certain substances with which they come in contact—affinities which we can demonstrate in our ordinary chemical operations, as well as prove to exist in the body. It is from facts and deductions such as these that I shall endeavour to trace out the cause of the apparently mysterious operations of malaria on the animal frame.

The existence of epidemic or infectious diseases in any locality—of a certain kind of fever, for instance, in places surrounded with cesspools, stagnant drains, or putrid marshes; of agues in damp undrained districts; or of cholera in filthy ill-ventilated dwellings—is of itself a sufficient proof that something is generated there capable of disturbing the ordinary healthy performance of some of the vital functions; and in endeavouring to discover this substance and to describe its
nature, it will be necessary for me first to call your attention to a class of chemical phenomena which appears to me nearly related to those changes which are produced by malaria.

It is well known that the elements which enter into the composition of many mineral substances are held together by so feeble an affinity, that the slightest disturbing cause is capable of producing their separation. The force which binds together the elements of the fulminates of silver and mercury, of the iodides and chlorides of nitrogen, and the peroxide of hydrogen, is so feeble, that the slightest friction, in some instances even a draft of air, is capable of tearing them asunder. Organic compounds, and particularly those formed under the immediate direction of vitality, such as the constituents of the blood and secretions, being of a much more complex nature than any mineral compound, yield to influences even more slight than those just named, and give rise to new and simpler productions. The ordinary process of decay, in which the elements of all organized substances begin to form simpler compounds by uniting with the oxygen of the air when their vitality ceases, or of putrefaction, in which they form such compounds from a new arrangement amongst themselves, is a proof of the facility with which chemical changes are accomplished. No leaf or stem can lose its vitality without at the next moment producing new compounds by decay; nor can any animal substance, without previous chemical preparation, be prevented from undergoing the process of putrefaction. The compounds produced by the ordinary process of decay, namely, carbonic acid, water, ammonia, and nitric acid, are generally so simple in their nature and harmless in their properties, as scarcely to be considered injurious to animal life. The carbonic acid produced from the fallen leaves of a woodland district would so soon and so perfectly mix with the atmosphere, as not to render its presence in excess at all appreciable. Even in summer, that
is, during the time decay goes on with the greatest rapidity, more than this excess of carbonic acid would be taken up by the leaves of plants during their rapid growth. In winter, when little carbonic acid is produced, in consequence of the process of decay being slow, all would be carried away in solution by the rains. In autumn only should we be likely to find a greater amount of this gas in extensive woodland districts than in the open country; but as this is not even found to increase the amount so much as to enable us with certainty to detect it, and can never be equal to that produced from the combustion of fuel in large manufacturing towns, we cannot assign any injurious tendency to its presence.

We must not, in fact, look to the natural process of decay for any thing prejudicial to the existence of life; it is a process ordained by an all-wise Providence to insure and maintain its existence. By it, dead and otherwise useless matters are converted into compounds useful in supporting the life of plants, and forming food for man; and by thus effecting a continued transmutation of matter from a state of death to life, it insures that uniformity in the earth's surface and in our atmosphere which appears so necessary to the existence of organized beings. It is a process, therefore, which, if allowed to go on with that regularity with which it was intended, and which does now go on in those healthy districts not yet over-crowded or polluted by the negligence of man, would still maintain the atmosphere in that uniform salutary state in which it formerly existed.

We must search among the products arising from those heaps of putrefying animal and vegetable remains, which, from being saturated with moisture, prevent all access of atmospheric air, and will not allow the natural process of decay to go on. Here we shall find not only compounds produced of an entirely different character to those generated by decay, but compounds the nature of which varies with
every change of atmospheric temperature, pressure, and humidity.

Although putrefaction is commonly regarded as a simple process, generating substances the history of which is well known,—producing sulphuretted hydrogen, phosphuretted hydrogen, carbonic oxide, &c., yet I am convinced, from experiments recently made, that the number of new compounds formed during this process is much greater than is usually imagined. It is, indeed, impossible to conceive the removal of one atom of carbon, hydrogen, oxygen, or nitrogen from any organic product, without, at the same time, leaving a compound possessing a character entirely different from the original. As these elements are gradually removed atom by atom, or as they divide and subdivide, probably many times, before the last products are given off, I maintain that some of these intermediate compounds may be of a nature capable of producing, when conveyed into the system, disease or death.

What is it that gives to the atmosphere in the neighbourhood of putrefying organic remains the various odours which characterise their presence? In many instances neither sulphuretted hydrogen nor phosphuretted hydrogen can be detected. It is not the simple odour of ammonia, nor of sulphuret of carbon; these compounds in many cases are absent. It is evidently some form of matter which has not yet been isolated, and the exact nature of which is certainly not understood. It is evident from this peculiar odour, which it generally, though not always, gives to the atmosphere, and more particularly from the deadly character which it invariably communicates to that fluid when present in quantity, that it is something capable of assuming the gaseous state, or of being dissolved in air, like other volatile fluids. Although it is impossible to detect any foreign substance in such air by the usual process of eudiometric analysis, yet when the air from the neighbourhood of stagnant drains is cooled below
its dew point, the moisture which then separates appears to contain a volatile putrid substance in solution. By passing the air from any putrid source through a tube cooled by ice-cold water, I have been able to collect a considerable quantity of this solution; but as yet I have been unable to separate the active principle from the water and other compounds with which it appears to be associated, and consequently have not been able accurately to ascertain its composition or properties. I think, however, that I have made out satisfactorily that it is a compound of nitrogen, but certainly not ammonia or nitric acid; for on first ascertaining the amount of ammonia contained in a given quantity, and the absence of nitric acid or cyanogen, I found the quantity of ammonia very much increased by subjecting it to an organic analysis. At first I suspected it to be one of those volatile bases recently discovered in Dipel oil, but subsequent observation led me to conclude that such was not the case. That it is a substance capable of undergoing rapid decomposition is evident from its watery solution, at first perfectly transparent, but in a few hours after being collected becoming perfectly milky. In one instance a gas was evolved during its change, but I was not certain whether it might not have been condensed by the cold. I therefore consider it a nitrogenous organic compound in a state of rapid transformation—a substance, therefore, similar to yeast in many of its properties, and which, like yeast, is capable of communicating a similar state of transformation to many nitrogenous bodies with which it comes in contact. That this communication of motion or change to matter in a state of rest really takes place in numerous instances, is a fact so well understood by chemists, that I must apologise for introducing a few brief illustrations.

One of the most remarkable changes of this kind arises when amygdalin, one of the constituents of the bitter
almond, and the kernels of stone fruits in general, come in contact with emulsin, another substance which they invariably contain. On breaking the little cell walls, which, in the natural state of the fruit, kept these substances separated from each other, the contact of the two instantly causes the elements of the amygdalin to arrange themselves in new forms, so as to produce sugar, formic acid, oil of bitter almond, prussic acid, and water; and thus, from a substance perfectly harmless, are generated poisons of the most deadly kind. Another curious change is communicated to starch by the action of a peculiar principle, generated during the germination of seeds, called diastase. When so small a portion as one part of this substance is mixed with a solution containing one thousand parts of starch, and kept at a particular temperature, the whole is converted into a solution of sugar in the space of a few hours. In this case there is no exchange of elements between the diastase and starch, no more than between the constituents of the almond; it is the decomposing nitrogenous matters, namely, the emulsin and diastase, which, in both instances, suffice to induce the change. In the same manner when we add yeast, a substance in a state of rapid decomposition, to a solution of sugar, we find the elements of the sugar dividing themselves into two other compounds, namely, carbonic acid and alcohol, without in any way sharing the elements of the yeast. Other matters undergoing a similar kind of transformation to yeast are capable of inducing a similar state of decomposition to solutions of sugar; but if the kind of transformation, as I shall presently explain, be different, that is, if the compounds it is producing be not the same as those produced by yeast, we shall have a different kind of decomposition induced in the matters with which it comes in contact. The communication of putridity from one piece of dead flesh to another, or from one piece of wood to another, are all instances of
decomposition from contact; and were we able so distinctly to see the state of the air in the neighbourhood of stagnant drains, &c., we should, on the same principle, be able to explain the reason why meats and other articles of food kept near to such places so soon become tainted. It inevitably arises from small portions of this putrefying compound being condensed by the moist surface of the flesh, and which causes it to undergo a change.

With these considerations before us, we shall now be able to form some conception of what really takes place when such substances are conveyed into the living animal system; for that a something, existing in the air of certain localities, entirely foreign to its natural constituent, must be conveyed into the lungs during respiration, is so clearly demonstrated by a number of facts as to amount to an absolute certainty; and that the introduction of matters into the blood in a state of putrefaction is capable of inducing a putrid state in some of the animal fluids, is evident from the dangerous and often fatal effects produced by dissection wounds. In this case the decomposition commences at the point where the poison was inserted, and extends, unless checked by timely aid, through the whole system. In some instances even the introduction of putrefying matters into the stomach has produced death. The poisonous sausages of Germany were found to contain no matters which, in an ordinary way, could be considered injurious to health, but were undergoing a peculiar kind of decomposition, which, being communicated to the system when taken as food, produced a wasting disease and ultimately death. The kind of decomposition induced in the latter case, or the kind of disease, is quite different to the former; they both arise from putrefaction, but the *modus operandi* of the change is different. Now, if the introduction of such poisonous matters directly into the blood, or even through the medium
of the stomach, be sufficient to cause death, surely the constant application of noxious exudations from a similar source to the large surface of blood in the lungs, will be capable of engendering disease.

That the moisture condensed from the air of stagnant drains, &c., is sufficient to produce symptoms of putrid fever and death when introduced into the blood of a dog, has been proved by Dr. Southwood Smith, and stated by him in evidence on sanitary matters before a committee of the House of Commons; and I myself have verified his experiments on other small animals. I therefore believe that it is to this putrefying substance alone that we must look for the causes of all forms of infectious disease, and that it constitutes the various forms of malaria, miasms, &c., which are emitted from putrid marshes, stagnant drains, and accumulations of filth of every kind. That it is not sulphuretted hydrogen, or any of the ultimate products of putrefaction, I think is sufficiently proved by the fact, that persons who conduct processes in which these gases are continually disengaged, and who live in atmospheres highly charged, apparently suffer no more than persons who visit such places occasionally. These gases are no more capable of producing infectious disease in the human subject, than those which result ultimately from the decomposition of yeast are capable of producing fermentation in a solution of sugar, or those resulting from the decomposition of diastase or emulsin would produce the remarkable transmutation of the elements of starch or amygdalin. If, then, we regard infection as arising from certain decompositions of the animal fluids, induced by the presence of putrid particles dissolved in the respired air, we should naturally expect to find such diseases prevailing to the greatest extent in sheltered valleys or yards, where the air was stagnant, and where such matters were allowed to contaminate the air continually; and that such is really the case we have abundant evidence in the
various sanitary reports which have been recently issued from the principal towns in the kingdom.

Having established the existence in atmospheric air of a substance in a state of rapid decomposition, capable of inducing disease when introduced into the animal frame, we will next endeavour to trace out the cause why disease, evidently produced from malaria, is capable of assuming various forms in different localities and at different seasons; and also the reason why stagnant drains, &c., should be a source of disease at one period and not at another.

We have already stated that the disease produced by decomposing sausages differs materially from that communicated from dissection wounds; and it would require a person to be very little versed in chemistry to see that the kind of decomposition going on in the sausages was entirely different from that in the putrid body. In the first the change is described as a slight softening, in which the mixture becomes lighter in colour, without the escape of any gas; whereas in the body considerable quantities of gas escape, and the substance becomes much darker. This difference in the kind of decomposition, which undoubtedly causes the difference in the character of disease, may arise from two causes; first, from a greater number of chemical compounds acting upon each other at the same time, or from a larger or smaller portion of moisture. We may, indeed, consider the presence of various quantities of moisture in organic compounds, or the degree of dilution of organic solutions, to be one of the principal causes which modifies the putrid decomposition of all organized bodies; for it is well known that when a certain amount of moisture is extracted from flesh, either by evaporation or the action of salt, this change is entirely arrested. We also know that the addition of a third substance to fermenting wort, namely, the bitter principle of the hop, has the effect of preventing the formation of an oily compound,
which would be generated without it. The presence of many vegetable acids in the fermenting juice of the grape gives rise to volatile compounds, which produce the flavour and bouquet of wine, no such compound being produced by the simple fermentation of sugar (the addition of rennet to milk rapidly converts its sugar into lactic acid); hence we may safely infer that the various mixtures which are constantly occurring in our stagnant house-drains and cesspools, as well as the extent to which these matters are diluted with water, will, at one time, so far modify or alter their mode of transformation, as to produce compounds which are highly injurious to health, while at another they would be quite harmless. It is not in all states of putrefaction that matter introduced from dissection cuts is capable of producing dangerous symptoms; it is only when the putrefaction assumes a particular form that such is the case. The same thing may certainly occur with putrid drains, &c. We shall at all times find putrid matters present in the air contiguous to such drains, but the decomposition will not always be of such a character as to produce disease.

Perhaps the principal agent which modifies the process of putrefaction, and determines the manner in which the elements of compounds shall arrange themselves to form new products, is temperature. Nothing is more common in chemical operations than to produce one compound from a certain mixture at a low temperature, and another at a high one. In the case of yeast acting in a solution of sugar producing carbonic acid and alcohol, it is only below the temperature of 80° that this decomposition occurs. At a temperature between 80° and 100°, the transformation of the yeast and sugar is so far changed, that instead of carbonic acid and alcohol, we have lactic acid and gum. In the same manner we have the elements of sugar of milk at one temperature dividing themselves into alcohol and carbonic acid, at another into lactic acid, and at
another into mannite and gum. If the putrid decomposition of such simple mixtures as sugar and yeast be so far altered by a few degrees of temperature as to produce compounds so widely different from each other as alcohol and lactic acid, how much more likely will it be to exercise a similar influence on the heterogeneous mixtures which constitute our undrained marshes or stagnant receptacles of filth? If we have poisonous matters produced from the decomposition of sugar at one temperature, and salutary ones at another, is it not reasonable to infer that such would be the case during the continuous and ever-varying changes which such matters are constantly undergoing? I do not think it improbable that the mode of decomposition in such matters may be altered by every change of temperature; hence we may have the same places at one time producing compounds comparatively harmless, and at another engendering the worst form of infectious disease.

That various kinds of epidemic disease are produced by contact with matters of a similar composition, although in a different state of change, is evident from the small pox virus, the matter of plague, &c. The remarkable manner in which such contagious matters reproduce themselves in the diseased subject would lead us to infer that if epidemic fever arose from the action of putrid malaria,—if it arose from a state of decomposition, communicated to the blood by contact, the modus operandi of its action would be precisely similar to that of contagious disease. We should have poisonous matters re-generated in the system, which would only differ from those of contagion by being volatile, and which would consequently infect the atmosphere by exudation from the lungs and skin. The reproduction of the exciting agent is well illustrated in the action of yeast in a glutinous solution of sugar, such as wort; and in this we have a neutral substance in solution, which, during the fermentation, is itself converted into yeast. I may say that the gluten here becomes
converted into an infectious agent, capable of producing disease in a fresh portion of a solution of sugar, that is, of effecting its transformation. In the same manner I believe that during the continuance of all those diseases really arising from malaria, a fresh amount of exciting agents, similar in character to the one originally derived from the putrid source, is generated in the blood and other vital parts; and that it may spread from a diseased subject and produce a continuance of the malady in the same manner as it may radiate from a putrid drain.

I am aware that chemical and other experiments have been made, with a view to prove the non-existence of any matters in the air of rooms occupied by fever patients different from those naturally contained in the external atmosphere; yet the peculiar odour perceived in all such rooms might have convinced the experimentalist that something foreign was present, and that their conclusions were erroneous. It is not by a simple analysis of the air that we must expect to find these highly-rarefied compounds; it is only by searching for them in the moisture condensed from the atmosphere in contaminated localities that we can hope to discover their presence, and learn their properties; and I do not despair, if this course be pursued, of seeing all these matters exhibited in such a tangible form as will effectually clear up the mystery which has hitherto hung over them. I am aware that Queckete, and other eminent physiologists, would attribute the action of malaria, and, I believe, all infectious agencies, whether communicated through the air or by mere contact, to the presence of mycelium, a microscopic germ or spore, capable of reproducing itself with great rapidity, wherever it finds a suitable soil for its development. I am too well aware of the presence of such spores, and their rapid growth and re-production during the vinous fermentation, and of many other instances in the vegetable kingdom, entirely to
discredit this hypothesis. There can be no doubt that as much mystery hung over the cause of the potato disease as over the phenomena of malaria; yet it is found to arise from a microscopic plant, whose habits appear to be similar to those producing mould or blight. The peculiar, and generally fatal disease induced in the human subject by eating rye bread, or using rye meal, containing portions of the ergot, has been clearly proved to arise from the rapid growth and extension of the mithelium, which produces the disease in the grain. It is true that the microscope has been directed in vain to discover these germs of fever in diseased subjects, and also in the putrid liquids condensed from infected air; but with our knowledge of the limits of the power of the microscope, we may conceive vital germs too minute for its reach; and consequently we must not altogether on this account discard an hypothesis which has certainly many important facts in its support. Probably the progress of the malignant cholera and some other epidemics could be much better explained on the mithelium hypothesis than on the putrefaction one; yet whether we believe it to arise from organic growth or decomposition, we must always bear in mind that the latter is invariably attended with the development of the former. In every drop of stagnant water—in every heap of decomposing rubbish, myriads of microscopic germs of life are developed and subsist; they find in it the food necessary for their growth, and the conditions necessary for their reproduction. It appears to me more rational to assign their existence to the peculiar state of the decomposing fluid, and not the state of the fluid to their existence. The various kinds of mould are only produced where they find the necessary conditions for their development. The yeast plant is not the cause of the decomposition of the yeast, but lives in consequence of its change. More than one microscopist has assigned the office of nature’s
scavengers to those microscopic animalculæ; and hence they would tend to diminish the amount of decomposing matters in the atmosphere, rather than increase it. We cannot, however, assign the same office to the various kinds of mould, smut, or blight; they will grow in the substance, and ultimately perfectly destroy the most healthy parts of plants, and even, in the case of the ergot of rye, will prey upon the vital structure of animals. If, therefore, epidemic disease is produced by the action of mithelium at all, it is produced by that of a similar character to mould and blight; but until we can see the germs of the disease, or are unable to find anything more likely to produce it, I think it more rational to adopt the theory—proved certainly to a certain extent, and established by the most conclusive facts—which assigns the phenomena of malaria to putrefactive decomposition.

Having now given a general outline of what appears to be the cause of epidemic disease in most instances, I will, in the next place, endeavour to point out those causes which appear to me most favourable for its generation and development. One of the most prominent causes calculated to produce disease, or render a large tract of country unhealthy, would arise from want of natural or artificial drainage. All vegetable and animal matters contained in a soil saturated with water, particularly those which, like peat-bogs and marshes, contain a large amount of such matters, will be in a constant state of putrefaction. The compounds produced in them, as in other mixtures, will depend on the temperature of the air, amount of moisture, &c., as above described. It would be almost impossible that from such sources, on some occasions, noxious matters would not be given off injurious to life. The position, however, of the undrained land, with respect to river courses, hills, and valleys, would very much modify its sanitary character. A marshy district, surrounded with hills, being protected from strong currents of air, and
prevented from having its atmosphere frequently changed, would become more highly charged with the soluble constituents of the soil than those freely exposed to currents, which would constantly remove it. The condensation of moisture, in the form of mist or fog, appears to be highly favourable to the development, and to increase the intensity, of malaria. It would be likely to do so by repeatedly bringing portions into solution, and thereby increasing and maintaining their decomposition. I believe that the putrid matter, once condensed and allowed to go on putrefying for a time, would, when again dissolved in air, be more likely to reproduce itself in animal bodies than before. Hence it is that the currents of air which, on still nights, descend down the hill sides, and become cooled so much as to deposit a portion of their moisture, in the form of fog in the valleys, or on the course of a river, do not only tend immediately to produce the effects just described, but, by bringing effete matters from a distance and concentrating them on such points, materially increase the action of infectious agents. Valleys and river courses have not only been the prevailing localities of cholera, but of many of the most formidable maladies which afflict the human frame; while elevated situations, from being constantly exposed to change of air, and not liable to nightly fog condensations, would be less likely to suffer. Low sheltered localities in towns, such as those so often described by reporters on sanitary matters as centres from which radiate pestilence and poverty in its worst form, and of which we found not a few during our inspection of Sheffield, may be considered to represent small tracts in which infectious matters are constantly generated, and for want of a free circulation of air are allowed to accumulate, to the production of disease and death. The inhabitants of every closely built-up court or yard in low localities, where stagnant drains or heaps of decomposing animal matter are allowed to
remain, are not only liable to become diseased, but are quite certain to suffer in health, more or less, from constant exposure. The habit of building most towns on the banks of some river or stream—done originally, no doubt, for the convenience of a supply of water, or for the transport of merchandise—has been the main cause that has rendered our principal towns so unhealthy, and our scale of average duration of life so low. There are certainly no means known at present calculated to obviate the evil entirely. Sheltered valleys and river courses will always be, from time to time, the scenes of stagnant atmospheres, fogs, and, to a greater or less extent, of a badly-drained soil. Towns in such localities must, at all times, be subject to the evils which attend such obvious sources of infection. A great deal, however, will depend on the nature of the soil on which the town is built, as well as on its exposure to these atmospheric influences. There are some soils so retentive of any liquid drainage which may soak into them, and so impervious to atmospheric air, that after a few years the whole surface acquires the condition of a putrid bog, while others are built upon a naturally or artificially porous surface, with a retentive clay subsoil, so that drainage can soak down, and convert the whole into a putrid mass, similar in condition to a stagnant pond partly filled with rubbish. In such cases it would be unnecessary for me to state that the results of putrefaction would be poured into the atmosphere in abundance. In some cases, however, the soil is sufficiently porous to allow all excess of moisture to drain away, and thus to leave the surface porous and permeable to the atmosphere. In such instances the process of putrefactive decomposition would be entirely prevented, and the healthy one of decay substituted in its stead. It is evident, therefore, that we should endeavour to imitate this natural process by artificial drainage as far as possible, for we should thereby prevent
the formation and distribution of poisonous particles, as well as the consequences resulting from them. I consider, indeed, that the greatest improvement which could be effected in the sanitary condition of this country would be the one resulting from such a system of thorough drainage in towns as would not only carry off all refuse from the immediate vicinity of the habitations of man, but which would render the surface porous to a considerable depth: for I regard the disinfecting powers of atmospheric air as being very superior to any artificial agent we could employ, inasmuch as it will prevent the formation of miasms, although it cannot destroy them. In many instances we find soils containing oxydizing agents in large quantities, which, in some measure, impede the process of putrefaction for a time, and perform the same office as atmospheric air. The peroxide of iron, in the red sands of Sherwood Forest and the red clays beyond, loses a portion of its oxygen by contact with decomposing matter, and prevents the formation of hydrogen compounds, which would be produced without them. I consider the presence of peroxide of iron in a soil as a great natural disinfectant, and one which, so long as it lasts, is capable of contributing very much to the sanitary condition of the district. But still this is not sufficient, in our present system of drainage in crowded localities, entirely to prevent the production of disease; but it must tend to render districts where it abounds more healthy than those where it is absent.

I will now name another agent, naturally existing in the atmosphere, to which I would not have attached much importance had it not been generated at a time when it appears to be most needed,—I allude to the peculiar compound recently discovered by Schonbein, and which he named ozone. It is a powerful oxydizing agent, produced by the electric spark,—a flash of lightning, for instance, in its passage through air,—and consequently will be found in the atmo-
sphere in large quantities during thunder storms. Now, as these storms generally occur in hot weather, when the air is more or less stagnant, and putrefaction goes on with the greatest rapidity, it would appear that they effected other important objects besides refreshing the soil. It certainly would tend to diminish the amount of putrid matters in the atmosphere. Schonbein has shown that atmospheric air very often contains this powerful agent; and he attributes all the phenomena of bleaching, and other forms of oxydization, to its presence. If such really be the case, we should at once perceive that the air contained within itself the elements of its own purification; and certainly, judging from the beautiful manner in which all the phenomena of nature are adjusted for our good, nothing appearing in the least defective, we should be led to conclude that such is the case, whether arising from the action of ozone or not. In consequence, however, of men congregating together and forming crowded districts, there must always be places in which organic refuse, of greater or less extent, will accumulate, and pour forth its noxious exhalations in such quantity as cannot be immediately destroyed by the action of the atmosphere. We have already stated that the decomposing contents of cesspools, stagnant drains, and other refuse, have been at all times a source from which emanate disease and death; and although this may be remedied to a considerable extent by better constructed drains, an abundant supply of water, and other regulations, the evil will, to a considerable extent, remain in our villages and hamlets, if not in our corporate towns. It is for the purpose of defending the inhabitants of such places against the evils to which they are exposed, that we propose the use of some of those artificial disinfectants so well known to practical men.

It will be evident from what I have already stated, that the presence of some powerful oxydizing agent would be the
most effectual means of destroying poisonous matters ready formed; while the addition of those commonly known by
the name of antiseptics, would, by arresting putrefaction, be
the most useful to prevent their formation. The action of
the former depends on the facility with which they extract
hydrogen from any organic compound, and thereby so far
alter its composition as to destroy its former properties.
Now, as we cannot very well conceive the existence of an
organic product of putrefaction, similar to those which
constitute the miasms of marshes, &c., to be free from
hydrogen, it is clear that such agents are effective. Chlorine
we may consider to be one of the most powerful oxydizing or
dehydrating substances we possess, and as such it destroys
organic colouring matter, or odours arising from sulphuretted
hydrogen, phosphuretted hydrogen, and other products of
putrefaction. It is best used in the state of chloride of
lime, a small portion of which, dissolved in water, will, by
absorbing carbonic acid from the air, liberate chlorine slowly
and gradually, though in sufficient quantity to purify the
atmosphere of apartments receiving the exhalations from
such sources as those above named. The same substances,
mixed with the contents of cesspools, &c., would, as long as
any chlorine remained, prevent the liberation of any injurious
compounds; but in consequence of this material being rather
expensive, other oxydizing agents have been proposed, and
employed with advantage in its stead. A person named
Ellerman has recently patented a persalt of iron as a dis­
infecting agent, which certainly decomposes noxious gases,
and will probably destroy the really injurious substances
which accompany them, if applied in sufficient quantity.
As long as any persalt of iron existed in a mass of organic
matter, decomposition would be very much impeded, if not
entirely stopped; while any injurious matters generated
before its addition would be entirely destroyed. Nitric acid,
produced in a state of vapour by pouring sulphuric acid on nitrate of soda or potash, placed on a heated plate, has been successfully employed in the wards of hospitals, &c. As a disinfectant it acts precisely in the same manner as chlorine, though probably with less energy. Nitrate of lead has also been recommended as a disinfectant for fluids, and, in consequence of its oxydizing tendencies, would probably be a very effective agent in destroying matters ready formed in the mixture, although I very much question whether it would arrest the progress of decomposition entirely. The expense, however, of procuring this agent will always be a prohibition to its general use. Any of these may be employed successfully, with very little precaution.*

There are other substances, however, whose mode of action, though not so well understood, is nevertheless of great importance, from the certainty with which they arrest the process of decomposition when mixed with organic fluids. Of this class are the various kinds of antiseptics, such as volatile oils, alcohol, coal and wood tar, and probably all their constituents, acetic acid, wood smoke, common salt, &c. The action of these matters is best seen when added to fermenting yeast or wort. If a single drop of creosote, or a small quantity of an essential oil, be added to yeast, it will immediately put a stop to the change it is undergoing, and prevent its communicating decomposition to a solution of sugar. The same thing takes place when these substances are added to flesh, or any nitrogenous organic compound. The common process of curing meat by smoking it with burning wood, in which creosote, &c., is generated, and of preserving animal specimens in alcohol or volatile oils, are instances of their preservative properties; and although this

* Since writing the above, I have ascertained that good chloride of lime contains four times the amount of available chlorine, and consequently will possess four times the disinfecting power, of Ellerman's fluid.
is the first occasion in modern times that the subject has been brought forward,—in consequence of the great similarity between yeast and the matter producing epidemic disease, I would attach great importance to any substance as a disinfectant which would so completely destroy the action of the former. The old plan of boiling tar and burning brown paper in places charged with noxious exhalations, as a means of disinfecting them, would not be without its use; for in both cases creosote, &c., would be diffused through the atmosphere in sufficient quantity to produce a marked effect; and I have no doubt, were such plans adopted and kept up on an extensive scale in places exposed to epidemic disease, they would very much tend to prevent the extension of the malady. It will at once be evident that the action of these substances differs widely from those commonly known by the name of disinfectants; for while the latter are principally calculated to destroy poisonous matters, when once generated, by changing them into inert compounds, the former is destined to strike at once at the cause of the evil, and, by a specific action, to prevent their formation.

Having now given a brief outline of the nature of malaria, its mode of production and propagation, as well as the conditions of atmosphere and soil most favourable to its development, and the various natural and artificial agents calculated to destroy it, we may deduce the following conclusions:—

1. That the substance commonly called malaria is a nitrogenous organic compound, which, when dissolved in water or animal fluids, has similar properties to yeast, being in a continued state of decomposition, which state of decomposition it is capable of communicating to the fluids of the animal body.

2. That the character of the decomposition, and the variety of disease it will communicate, differs materially at various periods.
3. That the sources from which the various kinds of malaria arise, are the decomposing animal and vegetable matters which are wholly or partly excluded from the free contact of atmospheric air; and that the kind of decomposition taking place under such circumstances depends on temperature and other causes.

4. That organic matters, freely exposed to the air and not saturated with water, will not produce compounds of the nature of malaria.

5. That the conditions necessary to prevent the formation of malaria are (in addition to a free access of atmospheric air) the same as those we should use to prevent putrefaction; and the means used to destroy it would be by the action of oxydizing agents and antiseptics.

A discussion followed, in which the Chairman, Mr. Haywood, Dr. Alexander, the Rev. W. Thorp, and Mr. W. S. Ward took part, and the obligations of the Society were expressed to Mr. Haywood for his valuable and opportune paper.

A Paper was then read—

ON A MECHANICAL COMMUNICATION FOR THE WORKING OF SIGNALS AND BREAKS ON RAILWAYS. BY WILLIAM SYKES WARD, ESQ., OF LEEDS.

Much attention has lately been paid to the effecting a communication between the engine drivers of railway trains and the guards in charge of the carriages; and also to provide means of communication between the passengers and the guards or engine drivers; but no method has yet been suggested so unobjectionable as to meet with general encouragement or support.

The directors of railways object to the expense of making