[Indigestion] / by W.J. Sinclair.

INDIGESTION.

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INTRODUCTORY.

THE stomach is the kitchen of the body. It has to perform the important work of keeping up the health and spirits of the various organs, by properly cooking and preparing their food. This process of cooking, as done in the stomach and its appendages, is called digestion. By stomach is here meant, not that indefinite region from the throat downwards which is usually delicately referred to by that name, but the bag or pouch with thin fleshy walls which is situated internally about the centre of the body.

Food is required to make up for the waste that is constantly going on in the animal frame. The waste is produced chiefly in two ways, by keeping up the animal heat and by the tear and wear of the tissues.

The body must be kept at a certain degree of warmth. A comparatively slight rise in the amount of heat, from whatever cause, is fever; and the warmth cannot fall beyond a certain point without bringing the processes of life to a standstill. When a piece of coal or other combustible burns in the fire it produces heat and gradually disappears, partly in the form of gas In our experience no bush burns without being consumed. In a similar way certain elements in our food are burned up in the body and partly conveyed away as a gas from the lungs. But a fire does not burn without a draught of air, and the more copious the supply of air the brighter is the fire and the sooner is the fuel consumed. For a like reason is a supply of air necessary in order that the ultimate changes of the food may take place throughout the system. The air required for this purpose is taken in by the lungs. Hence it is that the healthier the lungs and the purer the air, other things being the same, the changes throughout the system are more thoroughly carried out, and the digestion in the stomach is more

vigorous. This relation of the supply of air to digestion is a fact of the greatest importance in the management of the stomach.

The waste by tear and wear of the tissues shows itself chiefly in the form of urine, perspiration, and in the gas given off from the lungs, which is very different from the pure air taken in. Besides the refuse and indigestible parts of the food expelled from the bowels there is also a certain amount of material contained therein which results from the wearing of the tissues.

Some of the articles of food which we take to make up for this waste go more to maintain the animal heat, others to repair the flesh and bones, and brain, and other tissues of the body. But no food can be of use for either the one purpose or the other before it has undergone such preparation that it can be absorbed into the blood directly through the walls of the vessels, or by a system of tubes called lymphatics. With this object it must be got into a soluble condition so as to pass through the almost inconceivably delicate membranes of which the walls of the blood or lymphatic vessels are composed. Now the conditions upon which the perfect carrying out of these processes of preparation depends may be broadly stated to be a healthy condition of the digestive organs and a supply, neither too large nor too small, of suitable food. When the digestive apparatus has been ruined by disease or ill-usage not even feasts such as made Lucullus famous can tempt the appetite or serve to nourish; and if the food be unsuitable or in too large quantity the attempts at digestion are sure to be attended with pain or some other sign that the organs are in distress.

THE PHYSIOLOGY OF DIGESTION.*

When a morsel of food is placed in the cavity of the mouth it is immediately laid hold of by the teeth and begins to undergo the process of grinding and moistening called mastication which is to fit it to pass along the gullet. But this is not all. The process of digestion begins in the mouth. The starchy food, such as rice, potatoes, and bread made from fine flour, begins to be acted on by the spittle or saliva so that it changes from insoluble starch to a sort of sugar which is soluble. The saliva is formed in what are called glands, situated about the cheeks and root of the tongue, and is poured out in larger or smaller quantity as required into the mouth. The quantity may be measured by pints in the twenty-four hours, but it varies much according to the quality of the food. An appetising taste encourages the flow of saliva, and hence the

* Illustrated in the lecture by Marshall's Physiological Diagrams.

more agreeable the food the more chance it has of being well digested as far as the saliva can assist. Indeed, so willing is the saliva to give its assistance that even the smell of food makes it flow, as every one knows who has been kept waiting with a keen appetite in a restaurant. Even the imagination is sufficient to open the wells of this digestive fluid. Some people, with impressionable nervous systems, cannot visit a fruit show, with its luscious grapes and peaches, without swallowing so much saliva that one wonders how they get their supply for the ordinary purposes of speech and digestion for days to follow.

The mouthful of food when sufficiently softened is pushed backwards on the tongue. When it has reached a certain point it passes beyond the control of the will. A beautiful mechanism then comes into play, by which the opening of the windpipe and the passage leading upwards to the nostrils are closed, while the food is caught by the gullet and carried downwards into the stomach.

The stomach is, as has been said, a muscular bag. Inside there is a soft velvety lining, which is always bathed in a slimy substance called mucus, and which is thrown into folds when the stomach is empty. There are two openings in this pouch, one near the large round end by which the food enters from the gullet, and the other at the pointed extremity through which the contents of the stomach pass into the bowel. When the velvety surface of the stomach is examined with a magnifying glass it is seen to present a peculiar honeycombed appearance, many little dots being seen in each figure of the honeycomb. These dots are the openings of glands which exist in myriads throughout the lining of the stomach, and form and pour out a sour fluid called the gastric juice by which the food is digested.

Whenever a mouthful of food enters the stomach this gastric fluid begins to flow just as the saliva does in the mouth. At the same time the orifices are closed, the one from the gullet only opening as required to admit more food into the stomach. Whilst the gastric fluid is acting on the food contained in the stomach, there is a churning action kept up by the muscular walls of that organ. This action does not grind the food as it does in the case of birds that feed on grain and have a strong muscular stomach called the gizzard, but it helps to bring each part of the poultice like a mass of food which has already been ground by chewing, more completely under the influence of the gastric juice. The food in this condition is called *chyme*. It is evident that this fluid

will act upon the contents of the stomach more readily when the food is tender and thoroughly divided and broken down by mastication.

After the chemical action of the gastric fluid and the churning have gone on for a longer or a shorter time, varying with the nature of the substance to be digested, the food passes into the bowel. This is done by degrees. The orifice leading to the bowel opens just a little occasionally to allow food sufficiently reduced to pass. This orifice is called the pylorus, *i.e.* "gate-keeper" of the stomach, not gamekeeper, as a medical student called it who received this morsel of information orally and whose knowledge of Greek or hearing was a little defective. The pylorus jealously watches the process of digestion in the stomach and undigested lumps which try to pass are turned back again and again to be submitted once more to the action of the gastric fluid. It is only after the stomach has, as it were, given them up in despair that the pylorus opens sufficiently to let them out. Now, how much of the work of digestion is done in the stomach? Suppose a healthy man takes a meal of meat and potatoes with a simple pudding of rice made with milk and sugar. The lean meat is thoroughly broken down and liquefied, so as to be easily taken up by the absorbent vessels. The fat of the beef is reduced to a mere oil, the tissue that binds together the cells of which it is formed being digested. The starch of the rice and pototoes is very partially changed into a form of sugar by the action of the saliva which is constantly swallowed; what is not changed into sugar is not digested in the stomach. Of the milk which coagulates immediately on entering the stomach, the cheesy part is digested just as the beef is; the butter remains an oil just as it entered the stomach, and the sugar and salts, always present in milk, are probably directly taken up by the blood vessels. The process of digestion is thus not completed in the stomach; the starch and fat remain essentially unchanged. During health this process of stomachal digestion goes on very rapidly so that "a full meal consisting of animal and vegetable substances, may nearly all be converted into chyme in about an hour, and the stomach left empty in two hours and a half."

Much of our knowledge of the process of digestion in the stomach has been learned from experiments upon animals, but a large part of it was acquired by observations made upon a man whose stomach could be looked into. Fifty five years ago, a Canadian, named St. Martin, was accidentally shot through the

stomach. A part of the front wall remained open, but the man recovered and retained quite good health. By pushing aside a sort of valve that formed to close the opening, the inside of the stomach could be seen and the process of digestion observed. Observations and experiments were made upon this man for several years, and a great deal of information was obtained concerning the process of digestion in the stomach, and the circumstances that aid or hinder it. Among other things Dr. Beaumont, the physician who made these observations, "constructed a table showing the times required for the digestion of all the usual articles of food in St. Martin's stomach, and in the gastric fluid taken from the stomach. Among the substances most quickly digested were rice and tripe, both of which were chymified in an hour; eggs, salmon, trout, apples, venison, were digested in an hour and a half; tapioco, barley, milk, liver, fish, in two hours; turkey, lamb, potatoes, pig, in two hours and a half; beef and mutton required from three hours to three and a half, and both were more digestible than veal; fowls were, like mutton, in their degree of digestibility. Animal substances were, in general, converted into chyme more rapidly than vegetables."

The emotions have an important influence upon the process of digestion as well as upon the appetite. Every one knows the influence upon the appetite of suddenly aroused feelings, such as grief, disappointment, or fear. Less powerful emotions act in the same way, only in a less degree, and so take longer to show their effects. Thus the worry of business or constant anxiety about the affairs of life, tells slowly but certainly upon the health, partly through its influence upon the digestion. Eager imaginative people suffer most; dull men are better off. One practical lesson from all this is, that meals ought to be cheerful and sociable, and that all grounds of domestic contention should be removed as far as possible.

When the chyme passes through the pylorus it enters the small intestine. This intestine is a tube about 20ft. long, with a structure somewhat similar to that of the stomach. In the lining membrane there is an immense number of glands of various kinds, whose functions are rather obscure. But by far the most important part of this lining membrane is the villi, or velvety projections, of which the membrane is almost entirely composed. These are continually bathed in the fluid contents of the bowel, and they contain the blood-vessels and lymphatics by which the nutritive part of that fluid is taken up.

In the first part of the small intestine immediately beyond the pylorus, digestion and absorption go on, just as in the stomach. But there is something more. Just below and behind the stomach is situated a large gland called the pancreas, which secretes one of the digestive fluids and sends it along a small tube or duct to this part of the intestine. This fluid acts on the starch just like the saliva, and, though it does other work, this is perhaps its most important function. So the starchy food is mostly digested in the first part of the small intestine.

Nothing has been said about the liver, and very little need now be said. You cannot take care of your liver except by taking care of your stomach and bowels, and if it becomes diseased you can act upon it only through the stomach and bowels, at least with rare exceptions. Besides doing other important work, the liver sends a fluid into the small intestine which we call bile. Owing to the chemical composition of bile, it combines with fat to form an emulsion which is soluble in water, just as potash or soda combines with tallow to form soap. And so the fat which left the stomach as a mere oil, mixed up with the chyme, is acted on by the bile in the small intestine, and made fit to pass into the absorbent tubes in the villi.

The contents of the bowel are driven onward by a muscular action like that of the stomach. The process of absorption goes on all along the intestine. All, or nearly all, the nutritive material is taken up, and only the refuse left. This, after passing into the large intestine, where some other changes in addition to absorption take place, is periodically expelled. When the large intestine is allowed to remain loaded, a considerable quantity of gas is sometimes given off from its contents, distending the bowel and producing distressing flatulence. Besides, the mere mechanical obstruction prevents the free flow of blood in the veins of the lower end of the bowel, and in this way the troublesome swellings called piles are formed.

The substances which we take into our bodies in order to undergo the processes which have been described, we call food. "A food is a substance which when introduced into the body supplies material which renews some structure or maintains some vital process, and it is distinguished from a medicine in that the latter modifies some vital action, but does not supply the material which sustains such action." There are some substances which lie midway between foods and medicines according to this definition

such as tea and coffee, and some stimulants. These change vital actions to a large extent, and also supply a small amount of material for maintaining vital action. The air we breathe has also such an important part to play in aiding the changes which take place in the food after it has been absorbed into the blood that some speak of atmospheric food; at any rate, it is not to be left out of consideration in treating of digestion.

When a perfectly healthy man takes a moderate meal containing all the substances required to nourish the body and maintain its vital actions, his appetite is appeased for the time, and the processes of digestion go on, accompanied not with pain or discomfort, not even with the consciousness of the possession of an alimentary canal, but with a massive, generally diffused sensation of the pleasurable sort. What the body requires is taken up by the absorbents or blood vessels: the refuse is regularly, and at not too long intervals, expelled from the bowel. With such a man the early stage of digestion does not produce too great languor so as to cloud the mental faculties: physically there is a sense of repose, mentally a state of contentment. The air he breathes is also food for him, and in some circumstances a stimulant which exhilarates without bringing perceptible reaction. A fair amount of work produces no approach to exhaustion, merely the feeling of the necessity of repose, which, like the appetite for food, is a sort of pleasure in itself, and the gratification of it is a pleasure. Sleep comes without wooing or bribing, and brings refreshment and invigoration.

The man to whom this description applies is a happy mortal, for it implies two things between which there is a constant action and reaction, a mind at ease and a perfect digestion.

But with our high civilisation this condition, which ought to be the lot of most, is the good fortune of comparatively few. In the struggle for existence or for place, and power, and wealth, many work only with their heads, most only with their hands, each class doing too much in their way. Many who are out of the struggle do neither the one thing nor the other, and so err after their own fashion. Those who can afford it eat vastly more than is good for them: the very poor eat food which is bad in quality or too small in quantity. Between stuffing and starving there is a golden mean, but also numerous degrees of departure from that mean. Whatever be the cause of transgression, it brings its punishment in the bodily or mental suffering, or the combination of both, which awaits the dyspeptic.

Such is the sympathy between all the organs of the body that any derangement of any one of them may cause temporary loss of appetite, or even permanent indigestion. But without going into the operation of these causes there is sufficient to occupy us with the conditions arising more immediately from the stomach itself. And this field for our attention expands wonderfully on the view when we consider that a vast number of the so-called liver diseases originate in the stomach, or are mere derangements of the stomach, arising from the facility with which that organ may be submitted to ill-usage. A "touch of liver" is not an unfashionable ailment; it is not too delicate or too coarse a subject for conversation. Troubles arising from the liver are vaguely supposed to be farther removed from the influence of the will of the sufferer, and so they form a fair ground for sympathy. The stomach is a more vulgar organ, and its derangements are suggestive more or less of the moral delinquency of too free indulgence.

The people who suffer from this class of liver diseases are not considered in the sequel. These are the people who can afford to study gastronomy as a fine art, seeking from a certain methodic gratification of the palate and indulgence of the appetite for food the same sort of refined pleasure that some find in music and painting, who, if masters in their art, may aspire to the distinction of the Roman epicures, who "were wont by taste alone to tell if a fish had been caught above or below a certain bridge, to tell of a partridge which leg it had slept upon, and to say of a wine in what latitude it had ripened with as much certainty as an astronomer can predict an eclipse." With these—the morally or physically paunch-bellied—the gastrophori—we have nothing to do at present. Our concern is with the men who eat that they may live, and who yet may, and ought within limits, seek to gratify the sense which waits upon nutrition, and which may supply, and no doubt was intended to be the source of, a certain amount of happiness. And I may state here that it is not my intention, in speaking of dyspepsia, to describe in a systematic way its various causes, symptoms, and modes of treatment. The symptoms, which are pretty well, perhaps too well, known, may be mentioned incidentally, and certain causes will be stated more fully, because in this instance causes suggest cures. To be practical, let us first inquire how those of you who, by the gift of healthy parents, or by careful management, possess a perfect digestive apparatus may set about ruining it. Lie too long in the morning, so that you must bolt your breakfast and hurry off to business—hurry through your

dinner, which has perhaps been hurriedly cooked, as if you had no teeth and no sense of taste, then scamper off immediately afterwards to work—smoke a lot in the evening, thereby drugging your saliva, or throwing it away, and substituting for that digestive fluid copious draughts of beer or spirits and water, and you may be a martyr in three weeks.

One of the commonest causes of indigestion is insufficient chewing. This arises not unfrequently from the possession of bad teeth, but is also very often merely a bad habit. We occasionally read in the newspapers of the sudden death of a man from choking at dinner while swallowing a piece of beef. This is an accident which may of course happen to any one, but it is a danger which hurried eating makes much more imminent. The danger of choking, however, is not the hurried eater's only peril. Retribution is only the more sure that it comes slowly. The stomach may struggle on for a while with the masses that are thrown into it, labouring overtime in its efforts to perform the work of a gizzard, but a time will come when its efforts become spasmodic, accompanied with regurgitation or with all the pains of cramp and colic, or its feeble exhausted action gives rise directly or indirectly to that sense of weight and distension after meals which is altogether incompatible with anything like physical happiness. Chewing takes time, but under ordinary circumstances it is not such an unpleasant occupation that men should hurry through it as if they were ruminant animals and would have another opportunity for mastication.

Take time to chew each mouthful of food completely; take time to allow the saliva to become thoroughly mixed up with it, and so give the starchy elements a start in the process of digestion, obtaining at the same time what incidental pleasure may be derived from the sense of taste. If you have been so unfortunate as to have partly or entirely lost your second set of teeth, apply to the dentist for such a third set as your means will allow, and give it a fair chance of doing the artificer credit, and, so far as teeth can, of preserving your health and comfort.

When large masses or lumps are permitted to enter the stomach, too much work is thrown upon that organ. The muscular walls keep up the churning action with more vigour, and probably for a longer time, than is intended by nature, and yet they do not succeed in breaking the masses down. The gastric juice is thus prevented from acting intimately upon the food as it ought to do, and the lumps remaining partially undigested are finally driven with more or less pain through the pylorus into the bowel. Such

lumps are not only lost as nourishment, but they do still further mischief in the intestine, passing on undigested to swell the mass of refuse in the lower part of the bowel, and so to aid in producing constipation with its attendant evils. The masses which occasionally stick in the bowel, producing obstruction, may be formed in many ways, not necessarily as the result of insufficient mastication, but no doubt the presence of lumps from this particular cause increases the danger of bringing on this terrible condition.

Indigestible food, however well masticated, or food taken in too large quantity, gives rise to all the ills of dyspepsia. According to the composition of the food and the general health of the individual the symptoms vary. There may be regurgitation of acid or acrid fluid, heartburn, pain and weight, distension with gurgling and rumbling, often so embarrassing—one or all of them. These troubles, when arising from this cause, may, as a rule, be soon disposed of by great moderation or a little judicious starvation.

A large quantity of liquid of any kind taken at meal times dilutes the gastric juice too much, and thereby delays digestion and not unfrequently causes dyspepsia. The other extreme, total or almost total abstinence from liquid, is also a mistake.

Another common cause of indigestion is indulgence in the use of stimulants. This is not a statement from the teetotal point of view. Wine and all the various alcoholic liquors supply us with a food capable of modifying vital actions such as is nowhere else provided by nature, but that this food is vastly over-used is just as self-evident as the fact that there is an enormous amount of overfeeding with those articles which we more usually call foods. Drunkards are always dyspeptic ; and even those whose habits fall far short of what would be called drunkenness suffer sooner or later. The dyspepsia produced by stimulants is usually of the acute sort, that is, it is produced by irritation leading to inflammation of the lining membrane of the stomach, and, according to the amount of mischief done, accompanied by more or less severe symptoms. "The symptoms are pain, sometimes vomiting, great amount of flatulence, with excessive acidity, foul tongue, impaired vision, flying specks before the eyes, palpitation of the heart, nervous tremors, sleeplessness, or broken sleep accompanied by nightmare, nausea, faintness, giddiness," &c., &c. ; indeed, any or all the symptoms generally included in the term "nervous debility." This extract from a recent popular medical book contains a sufficiently frightful catalogue of ills, and yet it is only too truthful a description of not uncommon forms of indigestion.

Reference has been made to flatulence as a symptom of dyspepsia. It is probable that during the healthiest digestion a certain amount of gas is formed during the time that the chemical changes are being produced upon the food in the stomach and bowels. Sometimes, however, owing to some of the many causes of dyspepsia, a very large amount of gas of various composition is formed in the stomach and small intestine. Besides the pain and sense of distension thus produced one very distressing symptom is the effect upon the heart. You have seen by the diagram that the heart is very close to the stomach. It lies, in fact, immediately above it, separated only by the thin fleshy partition called the midriff or diaphragm. Now when the stomach is much blown up with gas the heart is pressed upon and its action is interfered with, just in the same way as sometimes in disease it is displaced by fluid in the chest. Suppose now the pylorus suddenly opens, there is immediately a rush of gas into the bowel, the stomach collapses, the heart is suddenly freed from its constraint, there is a strange sensation in the chest, and perhaps a swimming in the head, a sudden thrill of fear or horror runs through the whole system, which is erroneously attributed to a different cause, and from that time the dyspeptic is haunted by a dread that he is the subject of some serious malady of heart or brain that may some day end in sudden death.

We have seen that strong emotions have a powerful influence on digestion. Anxiety and depression need not be extreme, merely pretty constant for a while, to produce dyspepsia, especially in people of a sanguine temperament. But whether or not the indigestion has been originally produced by mental causes, there is a mental complexion characteristic of the dyspeptic. "They are devoid of buoyancy, gloomy, and disposed to look always on the dark side. Frequently this depression is caused by anxiety respecting health. They are apprehensive of the existence of some grave disease, such as consumption or an affection of the heart. . . . . Their attention becomes concentrated upon themselves. They are constantly watching the sensations connected with digestion, and fall into the habit of counting the pulse, feeling the heart's beat, examining the abdomen, urine, &c. This mental disorder, carried beyond a certain point, eventuates in the forms of mental aberration known as melancholia." One phase of the influence of the state of the stomach upon the mind universally observed is contained in the proverb—"A hungry man is an angry man;" but the temporary irritation of an ordinarily

mild-tempered mortal kept waiting for a meal is a mere flash in the pan to the terrible conflagration of wrath of an individual of the nervous temperament suffering from some of the forms of dyspepsia. The victim is unhappy himself, and a cause of misery to those about him.

Intellectually, the dyspeptic is oftener than other men below the mark. A man cannot do the best mental work he is capable of when in actual pain or in low spirits. It is said of Robert Hall that during the most active part of his life he was never free from the consciousness of the existence of a painful malady. It is not improbable that if the disease had primarily affected the stomach we should never have heard of him. A great historical illustration of this thesis is the loss of the battle of Leipsic by Napoleon, because, so it is said, he was suffering from an attack of dyspepsia brought on by a hurried meal from a shoulder of mutton and onions.

DYSPEPSIA AMONG THE ARTISAN CLASS.

Dyspepsia, from whatever cause, is not so common among gormandisers as might be expected. It is extremely common among nervous people who occupy positions of responsibility and among men of sedentary habits who are worried by the cares of business. It is also extremely common among a class who ought to be entirely free from it—the artisans in our large towns. Of course there are no figures to enable us to say what is the relative proportion of sufferers, but from what one sees and hears an impression is produced that very few men over forty years of age are quite free from it. The discomfort arising from indigestion is so general that unless the ailment assumes a severe form little complaint is made. It is accepted as a condition of existence not to be escaped from any more than hard hands, impure air, or limited house accommodation. Some of the causes are almost or entirely unavoidable, but the most potent are to a large extent under the control of the individual. Beer drinking is one of these, but no man in this country is compelled to drink too much beer, however near to compulsion the temptations put in the way of the workmen who make and distribute that commodity may sometimes amount.

A constantly acting cause of indigestion among workmen is the hurried manner in which meals are eaten and the necessity for active exercise immediately after. Some of you may have heard of the experiments made by a physiologist upon dogs in order to

learn the effect upon the digestion of exercise immediately after eating. Two similar dogs were taken and supplied at the same time with a full meal. One was kept at home and allowed to sleep, the other was taken out for a run. They were both killed after several hours, and it was found that the dog which stayed at home and rested had completely digested its food, while in the other the process of digestion had made very little progress. And so both physiological experiment and our own every-day experience teach us that it is prudent to "rest a while" after dinner. There is an apparent exception in the case of schoolboys, who immediately after meals take the most violent exercise, running and leaping like "troutlets in a pool." But a working man, or any man past his prime, with the nervous energy less exuberant, is not a schoolboy. No doubt a man whose occupation demands active exercise almost immediately after food, may, to a large extent, adapt himself to the slower and less perfect digestion, and undergo with perfect immunity what would do a grievous injury to one accustomed to a different mode of living.

> "A kick that scarce could move a horse
> Would kill a sound divine."

I do not mean anything disparaging by the figure of speech; it is merely a way of putting the fact that the exercise after dinner, which in the case of the labourer is only followed by a slowly-growing dyspepsia, almost as imperceptible as the accumulating bad effects of tobacco, would soon be the death of a university don or a corpulent Dutch skipper.

But of all the chronic causes of dyspepsia by which the working man suffers, both in health and in purse, the most potent, and at the same time most easily removed, is bad cooking. The man who has a wife who knows how to cook, and who patiently employs her knowledge for his advantage, is a fortunate individual. He is made the subject of the exercise of a virtue which ought to cover a multitude of other faults, for it adds immensely to his comfort and aids in prolonging his life. It is not always the fault of the women that so few are accomplished cooks. Want of knowledge of this sort is one of the "social wants" in our community. But I am afraid that few make the most of their opportunities. I remember one of the inducements that used to be held out to the diligent study of botany was that the knowledge of the structure and habits of plants would reveal beauties hid from other eyes, and so add to the interest and pleasure of walks in the country. That may be very true of botany and country

walks, but I know that some knowledge of disease, though it may add to the interest, does not increase the pleasure of walking through our streets. One sees, especially among children, the marks of incipient disease which is being neglected, probably because the parents are the slaves of a mere phrase as meaningless as common—"it is only weakness;" one sees distorted little legs and other deformities which at some time in their history, by the exercise of a little patience, might have been set to rights; and a host of other painfully suggestive sights. But one of the most unpleasant sights of all, and most suggestive of consequences, is a group of women gossiping in the street in the middle of the forenoon, when they ought to be cooking. I do not seek to libel the workmen's wives and sisters. I could say a great deal in their favour if it were relevant to my subject, but I am now mentioning a common occurrence, which I have no doubt is the cause of much pain and sickness, of waste of food, loss of temper, and domestic unhappiness. Food that is cooked hurriedly or carelessly can hardly be so appetising as it might be made, and appetite aids digestion. Meat is not unlikely to be rendered hard to masticate and digest, or, from loss in cooking of some of its principles, hardly worth digesting; and potatoes are almost certain to be in that unsatisfactory state in which it would require the gizzard of an ostrich to bring them into a fit condition to be presented to the absorbing surface of the alimentary canal.

There are some indications abroad that a time is approaching when the art of cooking will be considered of as much importance in the education of girls as the three R's. Let us hope that our digestive organs will hold out so that we may live to see it. And we trust that in the meantime the old girls will not be above profiting by any hints that may come in their way.*

In the shops and warehouses in our large towns there is employed a vast number of growing girls and young women, who live, upon the whole, monotonous lives, and many of whom suffer from ailments brought on partly by circumstances inseparable from their occupation, and partly by quite remediable causes. Those of them afflicted to the average extent are rather pale, sometimes haggard, often marked with eruptions on the face, which are a source of mental if not physical trouble. There is usually that

* Since the above was written I have learned with much pleasure that an association has been formed in this city with the object, among others, of affording the means of instruction in cookery to the artisan class. I hope the success of the undertaking will fulfil the highest expectations of the originators.—*W. J. S.*

peculiar air and expression of face that implies nervous debility, and which seen in a young man suggests fast living. Many of them are subject to a settled depression of spirits, or a depression which must be continually struggled against. The appetite is poor, sometimes fickle, and there is a general sluggishness of the digestive processes, with chronic constipation and all its attendant evils. Evening brings languor or exhaustion and morning does not bring complete resuscitation. Now many of these women are well cared for at home, and it is certainly not the home influence that is the cause of their sufferings. The truth appears to be that they are the victims of an atrocious system of feeding. They live a sedentary life during the day, often in an impure atmosphere, and they have not the same hygienic compensations in their leisure time as the other sex. Thus they require the greatest possible advantages in the matter of food in order to preserve health. But actually they have to submit to the very worst conditions. Their wages do not allow them to go to a good refreshment room for dinner; many bring food from home, and, as a rule, put up with the merest make-shift of a meal; and a large number of those who are provided with meals by their employers fare little, if any, better. It seems to be only in a small minority of places that the women are cared for as they ought to be. No wonder that so many are wretched dyspeptics, and, if they do not succumb to other diseases, suffer serious injury to health, which not only affects their own happiness in life, but has an important influence in deteriorating succeeding generations.

Now men and women cannot be made to act like mere machines of wood and leather. They cannot go on for an indefinite period starving soul and body with a few crude maxims of morality, and a very limited and unvaried supply of alimentary material. "With stupidity and sound digestion man may front much," but what is to become of the man or woman who enjoys neither of these blessings? The monotony becomes for many utterly unendurable; and there is no doubt that the rebound from dyspeptic depression and the constraint of a merely repressive morality often leads to acts whose consequences are ruin and misery.

The man or woman who is suited for the work, and makes a speciality of this field for social improvement, who has the ear of the influential, and knows how to speak the word to the wise, and so succeeds in bringing about the required changes in the environment of a class who appear to have few champions, will have done a work whose importance it would be hard to overrate, and

will have deserved at the hands of the community whatever honour and reward represents in these prosaic times the ancient civic crown.

THE FEEDING OF CHILDREN.

We ought to find the processes of nutrition going on most perfectly in the very young, and under favourable circumstances such is the case. The infant suffers from no disturbing mental influence. Its brain and nervous system are growing, not thinking. It is receiving impressions by the senses which are but the groundwork of thought. So the field is clear for the complete animal enjoyment of nutrition, and the result should be perfect animal health and beauty.

But here in Manchester how very different is the reality! We are often told how a certain large proportion of children die under five years of age, but no figures can give us an idea of the miseries that precede death, and we have no statistics of the injuries inflicted upon those who manage to struggle on a while longer, or even drag on a burdensome existence into adult life. And the vast majority of the children die from diseases affecting the digestive organs. Nature's rule for the feeding of infants is simple enough, and when it cannot be implicitly followed the nearest to it possible is the best course. One is occasionally met in one's efforts to put in a word for nature by the difficult argument, "a mother knows best." Now to one who knows intimately the domestic life of the people, and who sees the extraordinary processes of feeding against which infancy has to struggle, nothing can be more apparent than that a mother does not know, and that a grandmother is, if possible, farther removed from the light of nature by the erroneous teachings of tradition. But the real modern witches, who bring the babies under the baleful influence of the evil eye, and make them waste and perish, are the wise women who haunt the artisans' homes, and carry with them, as insignia, not the orthodox broomstick, but a bottle of castor oil.

Our greatest living poet puts into the mouth of a misanthrope the words :—

> "When a mammonite mother kills her babe for a burial fee,
> And Timour-Mammon grins on a pile of children's bones,
> Is it peace or war? Better war: loud war by land and by sea:
> War with a thousand battles, and shaking a hundred thrones.'

And in our large communities there can be no doubt that the sort of crime here suggested is occasionally perpetrated, but it has

been distinctly shown to be of comparatively rare occurrence. The fact is the people perish, not from crime, but for lack of knowledge. None mourn more sincerely over the sufferings of their infants than the ignorant mothers who unconsciously inflict the suffering. There need be no question of intentional injury. Neither is the nurture of children a mere subject for the so-called intuitions of a civilised nurse. It is a question of following the inexorable laws of nature or bearing the inevitable consequences.

If you put a little food into an infant's mouth before its teeth begin to appear you will see that, just as at a certain age it does not shed tears when it cries, so now its mouth does not fill with saliva. The fact is, the glands which are to supply that fluid are not yet in full working order. It may be said to have no such glands, just as we say it has no teeth. A time will come when the child will "slaver" a great deal, and then it will be said to be "teething," although the growth of the salivary glands thus indicated is a distinct process preparatory to the digestion of certain kinds of food, just as the growth of the teeth is. Everyone can see that an infant has no teeth, and therefore nobody thinks of giving it hard peas to chew; but everyone does not reflect that an infant having little saliva can digest very little starch, and so starch continues to form a large part of the food of infants. Yet each unbroken grain of starch in a mouthful of potatoes is just in its way as difficult a subject for the stomach and bowels as a hard pea. The starch grain is covered by a husk as insoluble without the proper fluid as the covering of the pea, and so in the aggregate they merely fill the alimentary canal without supplying nutritive fluid, or they give rise to pain and other dyspeptic symptoms by the presence in the bowels of contents which can be only partially digested.

The process called "teething"—the mere cutting of the teeth—is only one of several processes which are going on at the same time preparatory to the use of a mixed diet. Changes are going on along the course of the alimentary canal by which the organs are made fit to digest other food than milk, and the growth of the teeth is neither more nor less important than these other changes. Now until these changes in the mouth, in the stomach, and in the pancreas and bowels have taken place an ordinary mixed diet is injurious to the child, and is by far the most common cause of the nervous symptoms, of the pains in the stomach, of the attacks of diarrhœa and other ailments which so often develop into fatal disease because neglected at the beginning, under the belief that

"it is only teething." In spite of these well-established facts the feeding of children among the working classes does not seem to improve. We have continually to be seeing wizened little things that excite wonder and perplexity among their relatives by not thriving in spite of the most copious supplies of every aliment that is supposed to be peculiarly nourishing. One of the commonest and most pernicious superstitions is the dread of mixing milks. and so the infants whose mothers have to work are condemned to starvation during the day by having to swallow messes of boiled bread and butter which are neither palatable nor nutritious, while some, through sheer ignorance or weak indulgence, are allowed, from the first days of life, "a bit of what is going." Various kinds of cheese, salt fish, bacon, and sausages are all used to tickle the infantile palate and rack the bowels with gripes, and we not unfrequently meet with an unweaned reprobate who has acquired a taste for beer. Quite recently a child was under my care while suffering from one of the infectious fevers. During convalesence the patient had several suspicious attacks of illness. Careful directions had been given as to diet, but on making inquiry I learned that this child of three years "would call out for beer and sausages"—articles whose very existence should not have been known to her.

The effects of this sort of feeding are seen not only in the actual sufferings of the infants, and in the troubles the parents have to endure from loss of rest, but they can be traced in the readiness with which such children succumb to other diseases than those directly referable to the stomach, and in after years in the small stature, or in the deformities and chronic diseases of youth and manhood.

But the mischief is not merely physical. The mind does not get a fair chance. "There is a general connection between size of brain and mental energy. . . . Men distinguished for mental force have, as a general rule, brains of unusual size." In early infancy the brain grows more rapidly, and if growth be much checked then, there can be no doubt that the intellect suffers. It is well known that the children who used to be collected in the foundling hospitals in Austria and handed over to the peasants in the military border, in order to recruit the soldier population there, mostly died; those who did grow up developed into the dullest soldiers in the world—a result, no doubt, largely attributable to the mere physical effects of starvation in infancy. And the same process goes on to a large extent among ourselves, and is not con-

fined to those whose children are kept on short allowance from poverty. The amount of mischief done is difficult or impossible to estimate, but it is probably a vast obstacle to raising the standard of intelligence among the class affected.

One of the chief causes of neglect of regimen as to diet and the management of the stomach, and one of the greatest obstacles to removing the ills that follow the contravention of nature's laws on the subject of food, is the prevalent superstitious belief in physic. "Plebs amat remedia" is an old observation, and the people are as credulous about the cures by mere drugs now as ever they were. I say nothing against the use of medicines. No one who knows anything about the subject, and is capable of reasoning from cause to effect, can deny the immense importance of drugs in the treatment of disease. But some diseases require more of medical treatment than others, and in no department of medicine is mere physic of less use than in the treatment of indigestion, and in none is regimen more important. To use drugs, as is often done, in order to combat the effects of too free indulgence in food or drink, or of other injurious habits, whilst the origin of the evil continues unaffected, is utterly irrational, and it is certain to be futile. As long as people believe that dilapidated stomachs can be repaired by drugs without the exercise of moderation, or perhaps painful self-denial, as long as mothers stuff their children with all manner of deleterious articles, owing to a more or less culpable ignorance, and then hand over the disordered little machines to mere medicine men and wise women to work their will upon them, we shall have to lament, as heretofore, all the rampant evils that have been here suggested or described.

In our large towns—here in Manchester, for example—the medical institutions are not unfrequently mere temples of the reigning superstition. Many hundreds of pounds are annually subscribed by the charitable to support the hospitals and dispensaries. A very large part of the money is spent in drugs—a much larger part than need be. The dispensaries are crowded with applicants for relief who come for physic, and listen for the most part impatiently to advice. Unfortunately their patience is not much taxed. Few medical men care for the trouble and the unpopularity of pressing upon people what they do not wish to have. A routine is established. Each patient after being hurried through the periodical inspection, goes away with one more bottle of physic and a few days' hope; and so the old errors remain undisturbed, and the new light is confined to the few. This state

of matters is all the more to be regretted because these dispensaries are almost the only points of contact between a numerous class and the medical profession, and people who frequent these medical charities are, as a rule, just those whose lot in life is such that they are engaged in a constant struggle with the evil influences of their environment, and they most of all require the foresight that knowledge gives, and all the aids of medical science to prevent or palliate the inroads of disease.

The belief in physic just referred to is one of the chief causes of the slow growth among the people of a scientific knowledge of diet. Our popular dietetics may be described, not unjustly, as a mere chaotic mass of stout old prejudice and capricious opinion, along with some slight indication of the science that is to be. What is suitable food under certain circumstances can be ascertained only by a purely scientific process of observation and inference. The introduction of sentiment into the question merely complicates matters, and makes the result unsatisfactory. Yet all manner of prejudice and questions of morality are mixed up with what would otherwise be comparatively simple scientific problems. Dr. Samuel Johnson's epigram about food for horses has kept up the national prejudice, and almost excluded oatmeal from England, while whisky has made a successful invasion. The question whether alcohol is or is not a food is not more easily answered by science while a war of passion is raging over the moral consequences of the answer; and 'vegetable duck' is not made more nutritious and digestible because he who eats it is proud of being free from the blood-guiltiness of killing, or of being accessory after the fact to the death of a living creature.

In the present state of knowledge and opinion, and until diet, as a preventive of disease, gets the same popular attention as our water supply and sewage arrangements are now receiving, perhaps the safest course is to avoid the falsehood of extremes in opinion, and the danger of extremes in practice, and wait for more light.

ON SOME INVISIBLE AGENTS OF HEALTH AND DISEASE.

BY R. ANGUS SMITH, PH.D., F.R.S., &c.

I MAY at first not appear to keep to the subject which the title indicates, but I shall come to it by degrees, first speaking of the wonderful position which matter has taken in the thoughts of men in later times, but referring especially to such substances as are found in the atmosphere. We may take this century as containing types, very highly developed, of theories and of beliefs both highly spiritual and otherwise; and it is especially interesting to observe how much that mankind has hitherto regarded as unconnected with physical causes is gradually being absorbed into the region of matter, not merely by our theories regarding the ultimate particles of bodies and their perpetual mobility, but by the continual discoveries of bodies of an organised character visible only when greatly magnified and the probable existence of others not yet traced.

There has been a transference of power from abstract forces to apparently more easily comprehended matter, and the tangible has taken to a large extent the place of the intangible. I will not say that the primary movements have been made more intelligible, but the mode in which creation has developed itself, the materials with which it has worked, and the method by which the labour has been effected, if we may so speak, has been made clearer to us over a very large field. It is a marvellous thing to look at old ideas of matter, and even those which many of us, perhaps most of us, have been taught in childhood, and to look now at the opinions regarding its wonderful subtlety, activity, and persistence.

If this century has brought out these ideas it is not because they all entirely belong to it. Plants have their roots in the darkness of the ground, and ideas in distant history.

Indeed, we may say that this century has shown a growth of literary as well as scientific power, such as in some respects has never before been known. The world will some day wonder at its poetry, as men are afraid to wonder now, lest they should be found deceived by nearness. It has given us examples of religious movements also, which may be compared with some of the most extraordinary of former times; and although saints may be less visible to the eye, the power of faith has shown itself to be, as it ever must be, great.

All these movements show a desire of the mind to rise to its own dignity out of the thraldom of the material world. We may say that every faculty of man, with every art and industry, seems to have risen, if not to greater power, at least to greater general activity. Commerce itself, which some have thought the most grovelling of all things, took a greater flight upwards than ever it had taken before, and who would have thought that the little keeper of a huxter's shop should expand into a merchant prince, and do more for India than its greatest mogul. It was in the midst of such a struggle in humanity that science, long ago born, but weak and tender, rose to such strength as a powerful youth possesses. It came with a force of the greatest and purest kind, and worked like a creator; I scarcely exaggerate the phrase. One almost might suppose that the voice of the archangel at the end of time had come and moved the lumber of matter that had been lying over us keeping us in our graves. The world began a life of resurrection. There was a new heaven and a new earth. What nonsense, do you say? No, it is no nonsense. The black and dirty coal which for centuries was hateful to us, against which the nations struggled in vain, and which, at best, men despised, became almost suddenly a jewel, a diamond, a sceptre of power, a mighty army of faithful servants, a uniter of nations, a messenger of commerce and peace. It was an evil spirit turned into an angel; it was the resurrection of that blessed sunlight which had warmed our island ages ago. Clay itself, the basest of things, the very emblem of degredation, showed itself to be made of a metal so beautiful that it may be compared to silver, and of a gas so valuable that it has been called vital air, the air of life. These instances are enough to show that a new creation had dawned on the world, a creation also like that of the former, made out of the chaos or rubbish that was at hand.

The powers of nature seemed to be rising and asserting themselves, and in physical inquiry, as well as in the poetical and religious, there was an insight into the workings of the great soul

of the universe and man further than had been previously expected, and promising still more. The dead matter seemed to be as a trifle under the hands of the forces in the universe, of which, if there were found no new ones, there were, at least, found some extending themselves beyond all imagined bounds. Soon, however, the ideas of force and of matter took different relations.

Now, I will not say that all, or even any, of these things to which I allude began in this century. It is difficult to tell when anything begins, and the origin of some of man's best thoughts has, like the source of the Nile, been a problem for many centuries. But I think it fair to take this century as a time in which all took firm root and sprung up as if anew. It is especially in this century that the habit of reading has intensified every movement of the mind; every thought is copied on many memories, and that which formerly moved slowly, being driven only by one brain, is now, as by a steam plough, sent along the furrows with intense force.

It is fair to view our times as a new start for the world. In a certain sense we may say printing began in this century. For fifty years the power of mind over matter seemed to be revealing itself. In the midst of all this wonder at the powers of nature, it is remarkable how by degrees these powers left their separate hold, and all seemed to centre in one idea, namely, the greatness and multifariousness of matter; one may say the power of matter over mind. The wonderful masses of it seem to frighten us as we try to picture to ourselves the heavens and the distant bodies, so far that all our little lives would be a small step on the way to them. We then imagine our relation to and our connection with these bodies, and come to think that there is matter in the whole of the apparently empty space between us. Perhaps nothing gives us a more bewildering idea of the minuteness to which matter may be reduced, if we may use such an analogy where analogy is difficult. The rise of matter, so to speak, from its contemptuous inactivity and its mere lukewarmness and inertia, to an active power, has operated very much on the literature of the country, and the poets seem to be oppressed with the thought, and some who have begun spiritually have given up in despair and in full allegiance to matter. Now the idea of matter is that of constant restlessness manifested in the great or the small,—the great masses are constantly moving, and so are the smaller and most minute of all the atoms which make up the whole, and which are so small themselves that many, many millions are required to make a grain; they too are characterised by constant and rapid movements, resting only, if

they ever do rest, when they are held down by an equally strong power. These minute bodies are but little known to us, but they are working constantly so as to make up the life which we have. But bodies such as these are very small in comparison with those even the most minute which make up the smallest organised beings, and yet those which we cannot see without a microscope are very numerous. It is not two hundred years since this region began to be opened up to us. I told you that science had shown us a metal like silver in the clay under our feet, so Leeuwenhoek showed us a world of living things in waters supposed to be perfectly pure. His eyes multiplied the creatures bearing life to an extent that we cannot estimate, and diminshed the size of the smaller to an extent even now hard to conceive. It must have been a wonderful sight to Leeuwenhoek when he first saw the particles or corpuscles which are in blood and counted their numbers. It must have been a glorious new revelation to him when he ran wildly through all nature, finding unheard of structures, in trees and flowers, and strange forms, minute crystals in apparently shapeless masses, and definite structures coming out of water, showing the inclination that even matter such as common salt has to take a beautiful shape, made by a rare and minute geometry.

These minute forms observed by him—let us say blood corpuscles, about 1-3000th of an inch in diameter—are great bodies to those which are first mentioned. These red discs are circular and flattened, and consist of a delicate membrane enclosing a red liquid. They are not simple, then, but must be composed of many parts, or they would be unfit even for the mechanical offices they must perform ; if water be added to them they distend or burst. The liquid, too, even the smallest part of it that we can see with the best microscope contains a number of substances which in the bulk, at least, can be chemically separated. We know there must be hydrogen, oxygen, nitrogen, and carbon. There must be iron, phosphorus, and lime ; there must be also potash and soda. That which this great microscopist saw was the world in little, then came astronomers with their view of the cosmos or universe, leading men to think of another extreme. When the calm-looking region of creation seen by the use of the telescope was found to be filled with worlds and suns and gaseous bodies, it was viewed not as a quiet wilderness but as a region full of activity. We may imagine these bodies far from each other, but that is a matter of opinion ; probably they are as near as the

mechanism of the heavens will permit. As they are, we are aware that those at any rate within our own solar system are sufficiently near to each other to produce decided, well observed disturbances.

But if these monstrous bodies which require such a mighty ocean of space in which to float are so difficult to follow and to examine, and if even very large ones are difficult to find, may it not be true that there are many smaller ones still more apt to elude us. The question is constantly answering itself, and in later years the smaller planets or asteroids, between Mars and Jupiter, have increased to such an extent that the general public seldom takes heed of them. They are going towards 200, and move around the sun, and have long moved unknown to us.

It has long been a favourite theory that the stars affect us, and the will of the stars has been another word for fate, so that an old system called astrology grew out of the belief. This belief is said really to remain still amongst a few of those who have neglected the teachings of science in modern times. A slight effect of course all bodies have upon each other, but that of the stars, and even of the planets, on peculiar spots of the earth or on individuals thereon is beyond our comprehension.

If we descend still lower in the scale of size we come to other bodies occupying parts of space, and in numbers so great that our imagination is again met with difficulties. We can scarcely go out on an autumn night without seeing what are called falling stars, and on certain nights in the year they are very numerous. It was hard for man to believe that bodies actually fell down upon our earth. From what place could they fall? But the world both old and new insisted upon it, and science has, at length, been able to grasp the idea. So long ago as 1,154 years before our era there is said to have been a shower of earth in China which lasted for seventy days; this might have been volcanic or otherwise. In Joshua we read of stones falling from heaven. The Phœnicians worshipped a black stone which was said to have fallen from heaven. There is an account of a shower of stones at Alba, near Rome, six centuries before Christ, and a famous stone which fell at Ægospotamos, in Thrace, was long preserved, and was as large as a waggon—it is in all probability lying somewhere for re-discovery. But since these days the records of falling stones are endless; the stones contain substances exactly the same as those we find upon the earth, but it is remarkable how many of the meteorites are of iron, and iron seems by some of the ancients to have been considered as made out of stars, one of the many

wandering ideas. We ourselves have the words shooting stars for meteorites, although we know that stars are too large to run down here to us with so little ceremony as these meteorites do. But we must get on, and only remark of these bodies that as there is at a certain part between Mars and Jupiter a number of little planets so there is at another part, and that a part of the course which the earth takes a number of small bodies varying from a minute size, which the unaided eye cannot detect, to the size of several inches; whilst there are some, although these we rarely meet, as much as several feet in diameter. A minute microscopic globule of iron seems a common form.

I am desirous of showing you what a busy place the sky or heavens must be; how numerous must these bodies be which have been falling annually over all the world for so long without exhaustion. We do not seem to have lost connection with the distant worlds to which, in some way, we were probably once more closely attached, formed as we are out of the same material.

And now that we have gone from planets to the minute microscopic bodies that fall as dust at times on the earth we must go a little lower still. We must not, however, say that all the dust which falls from the atmosphere has any necessary connection with very distant space. Showers of dust or fine earth, or so-called ashes, are apparently as a rule the result of volcanoes which send out clouds principally of steam which takes up with it solid matter in a fine form; by what means it is ground up in the centre of these fiery cones who can tell? but it comes out in showers enough to darken the sun to a considerable distance, and the finer parts will pass through the atmosphere for even thousands of miles. There are also modes of raising sand well known to all who read of the desert; the larger parts must fall soon and a sifting will take place interesting to follow.

It might be a question how far any considerable amount of meteorolithic matter, apart from the region of the volcanic agencies, ever fell in such quantities as to affect human health. Many theories have been held as to our being subject to changes of the atmosphere caused by influences of a cosmical kind, but no sufficient proof has been given. It may however turn out that the atmosphere is much more pervaded by this class of bodies than we imagine, and it may even happen that certain portions of the circumference of the earth may receive more than others. We are only learning to believe in their abundance, and who knows where our learning will stop?

But these are not the only unexpected substances that come into the atmosphere, invisible when in the regions above, and to a great extent invisible when they come down. To give an idea of the organic substances that the air contains we must lightly review a literature as old as history, and only growing to be more interesting. In very early times we hear of dreadful sights appearing to render man afraid. We read in Exodus, "The water shall be turned into blood." We read in Isaiah, "The waters of Dimon shall be full of blood;" but for the list I must refer to Ehrenberg's papers, and come nearer home. We read of a blood shower in England in the year 330; we read of water in Silesia in 786 having become the colour of blood; of blood coming out of the earth and falling down from the air, and crosses falling upon the clothes, and black drops falling on men. This sounds very awful to us, and we wonder if writers can really be speaking the truth. But we go on further, and turn again to Ehrenberg's list, and we have wells red with blood for fifteen days in Sicily, in the year 800, and in the same year similar appearances in England.

We hear of fire raining on the sea and burning up a vessel. Still later we hear of blood falling in Brandenburg and being seen upon the leaves of trees.

When we come down to 1500 we find these accounts very elaborate; the spots are not merely red like blood, but white, yellow, grey, and black. They are seen on the roofs of houses, and on dress; they are found in the larder, and even in closed chests (Hecker). When these things occurred at the time of great plagues, people ran out of the towns into the woods to escape infection, and the dogs were with difficulty prevented from getting the upper hand of man in the greatly depopulated country.

Not long after this time, however, an idea arose, and, although slowly, began to remove the horrors attending such phenomena, and a wise physician, George Agricola, spoke of these signs or spots being due to minute vegetation. The fact of their appearance in chests opposed the belief that rain was the origin, and the peculiar dampness of the atmosphere on such occasions gave an idea of some natural cause being at work, and not a miracle.

One may ask whether, in such times as we speak of, when the sweating sickness assailed England and England only, any cause existed for this exclusion. Writers of the time blamed the gross living of the people, and it seems to have been the case that those who lived worst were most readily attacked. This may be said of many evil things, they go to their like. This plague was local,

and we scarcely can say that, like wet and dry weather, it was merely compensative for some other extreme elsewhere. The existence of external agencies of extensive character affecting all the globe is best seen, perhaps, in tracing the cause of the black death from the year 1333 and onwards. Then the earth seems to have itself sickened, and convulsions, begun so far off as China, produced many circumstances which man cannot withstand. (I follow here Hecker's Epidemics of the Middle Ages.) We hear of parching drought in that country, succeeded by violent rain; of a mountain falling into the earth; of lakes being formed, and of want of rain; of a plague killing five million people; of swarms of locusts, and renewed pestilence and floods. A few years afterwards the commotion comes to Europe, but on its way it rests at the Island of Cyprus, where violent sea waves and hurricanes do their utmost to make the land a desert; and before an earthquake, a pestiferous wind is said to have come with a poisonous odour which caused men to die in dreadful agonies. This wind is one of the most remarkable phenomena we know. It is also said that a stinking mist advanced from the East and affected Italy. The formation of dreadful chasms and the existence of foul air are said to have been simultaneous, on a great scale. Of course we all know that sulphurous vapours come from the earth in many volcanic districts, and at times we hear of them coming on a great scale, but we know nothing near our own time at all equal to the convulsions as described from good authorities by Hecker in his "Diseases of the Middle Ages."

These accounts need not be multiplied; it is enough to say that they point to a condition of things not in the power of man to remedy wholly; but the accounts also show that even in those days more sanitary knowledge would have been of some advantage. For example, when rain was deteriorating the land and rendering the houses so damp that the very clothes preserved in chests became covered with growths, like aged rocks exposed to the rains of heaven, or the trees of a rainy country, in a narrow valley where ventilation is slight; it would unquestionably have been well had men known the advantage of artifically drying their houses with more care, but it may be added that even had they known this, the mode of building rendered it most difficult.

It does still point to something more. If the world is exposed to such attacks of sickness, if, like a human being, it becomes at times so convulsed that the nations upon it must tremble and die, then there are events driving the course of civilisation in a manner

apparently without the smooth law of progress, which we are now picturing to ourselves. Who knows how much the brilliant days of Assyria or of Greece may have been affected by some such events, besides those that we seem to know? We cannot imagine the keen witted Greek in his joyous Athens, keeping up his intellectual fire and his gaiety, when the columns of his beautiful Acropolis are injured by earthquakes, and the atmosphere in which he rejoiced penetrated by sulphurous gases. Rhodes seems to have been every few years reduced until from being a great and powerful city, it is but a fragment. I know that there have been other and important causes acting on Greece, but physical phenomena have acted there and on other countries violently.

It is, however, time to inquire if events such as these spoken of are known only as having existed in the long past, or if they occur in our own days. It is not within my province to speak of earthquakes, except as causing a change in the atmosphere. Of these we have heard of many within a very short time, and some of them of great violence—new islands being elevated and coast lines raised or depressed as of old; and if we have not known of any quite so extensive in its results as those alluded to, we read of one less than a century ago in Iceland, which not only caused great loss of life, but great permanent damage to the country. That of 1845, in the same island, was great also, although in a barren country like Iceland there is little to kill; another took place only last year, and that, too, was violent. If, however, we seek very destructive earthquakes within a few years we must leave Europe; and if we want to know of violent floods carrying off hundreds of thousands of human beings, we have only to go back a few weeks, and to a country so well known as India. France is only now endeavouring to bring to its former condition a district almost ruined some three or four years ago, the cause being violent rains, and we have already seen something of what violent dampness can do.

If we look more closely, we find that in modern times we are suffering exactly the same class of evils as those mentioned in early times. The potato disease came to us at a time when the wet weather was a very probable cause, and we know its results. It destroyed not merely crops, but nearly two millions of people who were victims of hunger; and we may wonder how we could permit so many deaths. This, too, happened in a nation with all the wealth and power of modern times. Even now, at this moment, we are struggling with famine in some parts of India, having only lately

finished a struggle of a similar kind, caused by the condition of the atmosphere, results beyond our control. It is sad to see the fields which ought to be giving fine crops becoming brown or black, and instead of giving out the scent of fresh vegetation, giving out putrid odours equally disagreeable and unwholesome, and that, too, for many miles, so that none can escape their influence.

Knowledge can cure some of these evils. We can warm the ground, and dry it by drainage, but nature goes at times beyond our powers of remedy. Sometimes excess of moisture cannot be avoided, and so we are subject to both that and excess of drought.

In modern or late times we have had, therefore, a condition of things closely resembling that spoken of as being in the early part of the sixteenth century, but we have not had it to such excess. We have had no organisms to any extent visible to the naked eye falling or appearing on persons or on their clothes whilst in wear, but we know well the amount of mould which everywhere shows itself when clothes are left in damp places, and these are unquestionably of the same character of evils to be avoided. We have not over great districts the rain of blood or the red rain or snow, but we have numerous accounts relating to restricted areas. I can give you a few instances. In 1849 a fine blood red sand fell in Sicily; it probably came from Africa. In the same year an ink black rain fell in Ireland. This contained many organic decaying substances, which, after a time, showed endless amounts of microscopic animals, polygastria and rotatoria. In the same year still more showers of red sand and red rain. Red snow on the Alps and in arctic regions has often been observed. But we might come down to the latest days if we were to follow all the accounts of red snow, of red sand, and of similar phenomena, and it is enough to say that the microscope under the hands of Ehrenberg, has shown numerous organised forms. The mode of their passage into the air is not quite clear.

With these historic phenomena before us and their effect on men's minds we see that it is not a new idea certainly that diseases come from the air. We read of Hippocrates, in Greece, keeping out one wind and letting in another, by stopping and opening windows, and also using perfumes and fires against plagues; and we have a whole series of such things till the result has culminated in sanitary associations. The celebrated botanist, Linnæus, seems to have had a wide view of the subject, and looked on these clouds

of sand, dust, and other bodies, as infernal furies, bringing disease out of the ætherial chaos; and in 1825 Von Eisenbeck spoke of the electricity of the air stirring the infusorial animals of the air to life whilst they fell down in storms.

These ideas were given without the vigorous scientific proof, which men now require, and they belong to the class of ancient observation made by keen observers and good thinkers unprovided with the special appliances which are needful for perfect proof. As an instance, we have Terentius M. Varro, in the second century, who speaks of minute animals which cannot be followed by the eye, but which enter into the body by the mouth and nose and cause troublesome diseases. This is a shrewd guess; he could not see the animals, but he reasons and concludes. Of the same class are the observations of Bishop Berkeley, which I often quote, of last century, who says: "The air is a mass of numberless different principles, the general sources of corruption and generation." Also, that "The seeds of all things seem to be latent in the air; the extremely small seeds of ferns, mosses, mushrooms, and some other plants are concealed and wafted about in the air, every part whereof seems replete with seeds of one kind or other."

Still, with all these ideas, and perhaps proofs, we have not yet examined all the evidence with sufficient minuteness; the expression of the case, as given by Humboldt, in 1847, in his cosmos, has the fullest approval of Ehrenberg, who certainly is an authority of the highest kind. Humboldt had talked over the subject with him, and unquestionably was inclined to think that he had produced the only absolute proofs. Speaking of the fowls and insects on Chimborazo, he says: "If the unaided eye shows the whole circle of the atmosphere tc be alive, the aided eye reveals to us still greater wonders. Rotatoria, Brachionaea, and a host of microscopic creatures are lifted by the winds from the drying waters; without motion and apparently dead they float in the air until the dew brings them near the earth, the covering of their transparent rotating bodies being loosoned; and probably by the nutriment found in all water, renewed activity is breathed into the organs. The yellow atmospheric dust of the Atlantic, which is driven from time to time from the Cape de Verd Islands far eastwards into Africa and into Italy and Mid-Europe, is, according to Ehrenberg, composed of microscopic silcious organisms. Many float for years, probably in the upper regions, and sometimes come down perpendicularly in air currents, whilst they are ready to spring into life." (P. 10, Ehrenberg's "Uebersicht," 1871.)

Still it is clear that, with all his experience and the discovery of 200 forms of life, this inquirer had not himself found, in 1848, any distinct foungoid bodies, although he says, in 1871 (p. 107), "Still lately there have been found in the air fungoid bodies to such an extent as to raise the discovery to one of the richest in results."

I will not at present discuss this more closely. It is enough to say that many observers are looking for vegetable and animal life in the atmosphere. From India Dr. Cunningham has given us beautiful drawings of many forms of vegetable life, and many ingenious contrivances have been made for hunting them down. The favourite method seems to be the use of glycerine, a substance sufficiently moist, soft, and tenacious to cause them to adhere without chance of escape. Even then, however, they are not visible to the naked eye.

It would take too long to tell you of all the theories on this subject, not novel, but risen to newness because of its increasing uncertainity. It is exceedingly difficult to find anything quite new; there are always roots stretching deep into antiquity, and the observation of long ages of men has in many things been marvellous, but we like to prove all things now.

After all you will think that I am scarcely coming to the point—viz., invisible agents. It is true that I have spoken of agents not visible to the naked eye, and agents too far off to be visible, but are there any invisible? To approach these we must just touch one or two theories. It has been said that these minute creatures, which make their abode in the air, live there permanently, and it has been also said that they are mere products of putrefaction, substances that arise from decaying matter, such things as we can detect by the sense of smell although we cannot see them. Is this really true? It is true that by the sense of smell we can tell of many chemical processes going on, and of plants, and of animals forming. If a room is beginning to have mould in it we smell it, and at a very early stage; the seeds or germs float about, and they are easily recognised by the smell although we do not see them; on the other hand, they exist when we cannot smell them, so that there is a stage before the one that we can recognise by smell. For example, we may see small specks of mould when there is too little to cause the atmosphere of the room to affect smell. When I leave my house for a while in damp weather I often find a small fungus growing on certain kinds of binding, chiefly the books bound in calf, but I must leave it a long time before I smell it, and even before we can smell it we can recognise it by the microscope.

If these germs affect substances around, do they not affect man? We have seen that the blood spots, as they were called, came at the time of disease, and is it not the case that plants or animals of the same kind produce every class of infectious disease? Such are the questions asked. If they do, is the action not like that of a ferment, which being in action itself sets other substances of a similar kind in action, and if so, what is a ferment? I shall not speak of all the disputes regarding it, some of them are very interesting, and it is curious to see how much old speculations have been confirmed by modern inquiries. Let us take the fermentation of beer, it is always accompanied by a minute plant, and it does not seem possible to carry on the fermentation without this plant. The inquiries on this subject began to have great interest from the time that a German chemist named, Eckmann, found that flesh and soup which had been boiled did not putrefy if the dry air which was allowed to come to it were passed through a red hot tube.

Now this at once pointed out the existence of living forms or at least organic bodies being destroyed in the air. Plants and animals are composed of substances readily destroyed by fire, but there are many other substances besides, which are destroyed by fire. Sugar, for example, is a common instance, an organic body which takes a crystalline form but is not possessed of life. The substances destroyed might be one of these.

Two other observers, Dusch and Schroeder, found that it was not necessary to burn the air, if it were filtered through cotton it was quite sufficient to prevent the substances which were in the air from causing flesh to putrefy.

The inference from this is clear; if these bodies do not putrefy, it is because the air is pure, and if pure air does not allow of putrefaction, and if putrefaction is connected with disease, then pure air will prevent all those diseases which are capable of being carried through means of the air.

You all know that fermentation is an action which takes place in solutions containing sugar. The sugar is decomposed, and becomes partly a gas (carbonic acid) and partly a liquid (alcohol). A French scientist, Pasteur, made use of this quality as a mode of proving the existence of organised substances in the air, and his experiments are very beautiful indeed. He also found that fermentation as well as putrefaction can be prevented by preventing the presence of common air, but if it has been passed through hot tubes or cotton, or even long tubes without cotton the fermentation

does not accur. He is especially mentioned as having almost exhausted this point which Eckmann showed. He found also that if the air were allowed to be at rest as in a quiet cellar, there was little action, and if the air were lofty as on the mountains there was little action, so that the bustle and motion of life stirred or increased those agents which caused fermentation.

Well, all these things point to solid particles. There is probably nothing more certain than this, that gases do not cause any infectious diseases. It is now nearly thirty years since I said this, and it seems to be fully proved. Infectious matter does not diffuse like gas; it may be carried away by currents of air, but it has not an innate activity like gas, which is continually in motion, and which therefore cannot remain either in a cellar or in the folds of a dress, as these particles do which produce fermentation or infection.

One of the most curious proofs of the fact that bodies exist in the air in a solid and crystalline state, and in a state of suspension in watery solutions, was found many years ago when working on air. I passed air through water for about three months, but before the air arrived at the water it was obliged to pass through glass tubes. I was very much surprised to find that the water contained very little impurity. It took me long to discover that the impurity was lodged on the sides of the tubes, which took up the drops and particles and retained them.

For this reason it is not an easy matter to find the substances in the air, and the method by which they are found generally does not, in my opinion, obtain all, although a great many. I will tell you a very easy way to find bodies in the air, quite invisible whilst there, some visible when taken out—very easy, at least when you have the appliances. You must first have very pure water; it must be very clear, and it must be freed from all other substances. I confess this is not easily obtained, and we go to a great deal of trouble to have it prepared of this quality. We suppose, however, that you have an ounce or two of this water in a large bottle, which must also be quite pure; another difficulty which chemists are obliged to conquer. One of the most important duties of a chemist is to learn how to clean dishes or vessels, such as he uses for his experiments. Having obtained the bottle and water, the bottle is filled with the air of the place to be examined. Insert a glass tube, attached to a little pump or bellows, reversed, and pump out the air from the bottle, when, of course, the air of the place rushes in. Shake the bottle then with the small amount of

pure water, and so wash the air. If the air be very full of solids you will see a certain turpidity on the first filling, if the bottle be the size of a quart and a half; but this we do not see everywhere. I have found it in the first bottleful in a cow-house and also in my laboratory.

It is common to see it when the bottle has been filled five times with air and shaken; and you may see it in the air of Manchester readily with from five to twenty bottles. If you go to the hills, as I have done in Scotland, you must fill the bottle scores of times, and yet you do not obtain the same turbid or milky appearance as here. This, you see, is a very ready way of testing whether the air has solid matter in it. There is no doubt that it has, and we do not require to go back centuries, as I have been going, to show that it existed; and we require no proofs drawn from falls of blood or lichens—rain of ink—rain of red sand or silicious coatings of animalcules; neither do we require to go to the Polar regions for red rain or the heights of the Alps to find the existence of organised bodies forming the red of snow. We can find solids at least, although not red, far too readily at home. I find them in the house. I go to the door and find them in the street air. I find them everywhere here; and it seems to be wonderful why it has not been known very long, and yet it has been attended to in a certain form. Every housewife, in a smoky town, knows it by the darkness of the windows, and the blackening of the blinds.

It may, however, be asked, Are these the substances or organisms that produce disease? One of the most direct methods proving the effect of minute organisms on the health is that shown in a most interesting volume on hay-fever, by Dr. Blackley, of this city. In some of the more recent observations he has made, he enforces the previous proofs of the great amount of the pollen of flowers existing in the atmosphere, and its direct connection with hay-fever, and his latest expression is, that "the influence which pollen exercises upon the mucous membrane and other tissues is of a mixed kind. The sneezing, I think, is due partly to a mechanical and partly to physiological action."

He finds the weight of the pollen, and speaks of one species so small that it would require thirty-seven millions to make a grain, whilst six millions are required of the particles of pollen of the English meadow grasses. This would have delighted the heart of Bishop Berkeley. Dr. Blackley then goes on to measure the amount inhaled in a day, and considers 1,760, or the 3,427th part of a grain, capable of producing the severest form of hay-fever. (My calculation for visible bodies was higher, and I feel afraid to think

of the number. It was nearly thirty times more—all could not be germs however.)

This may be said to deal with visible or invisible bodies, according as you choose to accept the term, but it is a very direct progress when Dr. Blackley shows that hay-fever can be produced at will by the bodies alluded to. In certain seasons, autumn for example, they come in abundance, and those who are subject to their influence must go far out of the reach of vegetation. It illustrates very clearly the difference of constitution of different people, when we see so few comparatively subject to hay-fever in a severe form, and it also shows us why in cases of epidemic pestilence some may be attacked and others be quite free. It does not, however, show us all that we want to know, it does not appear that persons who have had hay-fever are in the slightest degree favoured when a second attack begins, they are subject to the same results until the latest terms of life.

Dr. Blackley finds the pollen in greatest quantity high in the air. I suppose this to be only occasional, since it certainly does not agree with other facts; but if germs of diseases collected above and came down only on certain occasions, we should certainly be led to think "of the infernal furies from the ætherial chaos."

But you may still say that these agents are not invisible; they are visible to the naked eye when in great numbers, and they are visible by the aid of a microscope even singly. We must proceed even further. There are many bodies by no means microscopic, but large and strong, existing about us which we cannot see—glass, for instance. When glass is very clear and well made we may stare long through a window at a right angle to it and not observe it. I dare say you have all noticed that when new houses are obtaining their beautiful new glass windows the glaziers put upon the middle of each pane a quantity of whiting. This I suppose is to make it apparent that something is there; and if this mark is not used, the glazier himself is apt to put his hand or his head through the glass. At a house, where I was lately, a glass door from the drawing-room to a censervatory had been so well cleaned that a young man walked straight against it and injured himself much, and now an ornament is put on the door to indicate that "this is glass." But putting the head through a pane of glass is not an uncommon thing.

We are now obtaining gelatine in such a beautiful form that it is almost as transparent as glass, and parcels come rolled up in some invisible agent—invisible, at least in a diminished light. But

there is an objection to the partially visible, and so many of these gelatine covers have a colour red or green, partly to give them beauty, partly to make them visible. Now, it is a strange but true thing that the microscopic bodies found in certain waters are often transparent. Transparent large bodies are often made visible by some impurity or colour, or want of absolute transparency, just as glass is made more visible by being dirty, or covered more or less with smoke or dust. Some jelly-fish, as they are called, are large bodies, but in some situations are difficult to see. If they are very small they are less readily observed, but when microscopic animals are transparent we know there is still great difficulty in seeing them, especially as a very strong light is required in order to show small objects. To overcome this difficulty it is customary to add colouring matter, which may be absorbed by or combined with these little creatures. Sometimes it is taken up and shows their structure; sometimes there is a chemical combination of the whole. They are thus made to show their movements, although it may only be the colour which we see. However, this is not the whole proof of these minute forms. When the idea of diseases being caused by microscopic bodies became prevelent, many men rushed forward with their observations, and several persons believed that they had found the very germ that produced cholera. But although the inquiry has produced most interesting results, it cannot be said that any infectious disease has been found doing its work as a germ, or ready to act as such. Perhaps we may take Dr. Blackley's results as the most direct in showing the production of disease by bodies in air, or at least belonging to the most direct class. I am not sure that I know of any so marked and clear and pertinent. Even he does not find any one body producing the hay-fever, but on the contrary, very numerous bodies producing the same result. Neither is the fever produced infectious, that is, the living human body does not reproduce within itself the germ which produced the hay-fever; this does not bring us to infectious disease.

The germs which produce infectious diseases seem to belong both to the transparent kind, and to the very small kind, if we may judge from the difficulty of observing them; and if there are some which it is so difficult to see even by all our contrivances, it is not at all wonderful that there should be others still smaller which we have not yet seen. It is quite certain that they are not identified, that is, we cannot say, this germ produces cholera, and that germ produces scarlet fever, but it is apparently true that some exist which are still to us quite unseen if not invisible.

Now there are other agents that are unwholesome, invisible gases for example, but I have not intended to enter on this wide field; we might however spend a little time on the application of this subject.

If districts have different plants which send off different pollen, we have at once a difference in atmosphere readily accounted for, and we send people from a place rich in grasses to barren rocks on the sea side, and sometimes to the centre of great towns to avoid hay-fever. We have only to drive the argument a little further; when plants are different, their products of decay are different, and so we cannot expect the same disturbance of the life to take place in all districts or countries. In marshy places we have, perhaps, both these cases at work, we have the seeds of plants and we have constant decay going on. There is already a reason for the well-known evil of such districts, and for its diversity also in diseased places.

But animals as well as plants decay; however, this decay is so striking as to have been long well known as productive of disease. Still the decay of dead animals is one thing and the decomposition and changes going on in the living are another, and we are most certainly giving out at all times substances capable of producing disease, if concentrated. We are poisonous animals and infect each other by our presence. Of course this must put us on our guard, that is, we must take care not to live in crowded streets, or in crowded rooms, or even to have a room too small for one's self. These creatures and substances of which I speak will crowd in the air about you, and suffering is most certain to follow. "Out of question," as bacon says, "such smells (or as we should say organic substances) are the flesh or sweat of man putrified." It is marvellous how nearly the health of this country continues in proportion to its density of population.

But I think I owe you a little more information. I spoke of agents of disease but also of agents of health. I might get over the expression by speaking to you of good air, of the oxygen which is so necessary for breathing, and the want of a constant supply of it, as pure as nature gives it for the health. I might also speak of ozone, which also is invisible and quite absent from the air in our smoky towns, although most abundant on the sea shore, where we so often recover health, but this was not exactly what I meant to allude to. We know that in many places men grow better, *i.e.*, of a better build and stronger, than in others. The cause of this is not always clear; sometimes it is. We know pretty well that negroes grow in warm damp places where white

men do not grow, and Hindoos grow in the warm plains of India where Europeans cannot rear their children. There are a few well known facts in ethnology, but a greater number of guesses. Still it is quite marvellous how long the type of a particular class will keep to one place. There are two reasons given : one is that the place makes the type, and the other that the type will remain until it is driven out.

In a most interesting paper by Dr. Beddoe, which I cannot quote exactly at present, because I have lent it, there is an account of the height and weight of the population of various places of Great Britain. There is a good deal of irregularity, still it is clear that the agricultural population are the largest, as they are also the longest livers. But some parts even of this population are much more powerful than others, and one would like to know the cause. It seems to be true that the air of the country is really wholesome and feeds great and powerful bodies, but then we have just seen that the air of marshy places is unwholesome, and these are country places, and we must not allow the contradiction. It is also well known that to dig up the soil deeply in India, especially in places where there has been much vegetation, is very dangerous, and the makers of railways in that country fall victims to fevers in great numbers. We have here two facts, and we must believe both, namely, that the soil may give out the most unwholesome bodies and the most wholesome. Some people, however, may say that the soil gives out nothing wholesome; that the health is produced by the purity of the air—the absence of unwholesomeness. We really do not feel able to confirm or contradict this. Mountain air is fine, but the biggest men are not fed on the highest mountains, although the most agile men may be. There may be many causes for this, but I bring forward one, and that is the quality of the emanations. The results obtained by the examination of the effects on fermentable liquids shows a very great variation in the amount as well as quality of these miscroscopic bodies and the effect will be various upon us accordingly. It seems not at all improbable that, putting disease aside, the irritable condition so frequently induced as one of the mildest evils attending air of crowded places, may be directly due to the microscopic bodies acting on the blood, and the calmness or the removal of irritation so often experienced by people at sea may be caused by the contrary. And we may say more, because we may look to the excess as producing far greater evils than mere irritability, and so on by gradation to the worst, But there is a great variety of irritability, and one of these is valuable, it is activity of mind. It

is a fact well enough known that this activity is greater in towns, and men irritated by excess of it can only be calmed by going out. Is it not probable then, that men who have no tendency to activity of mind may find themselves stimulated by this physical excitement of microscopic organisms and organic decomposition? The activity of towns has its mental and moral side. Here is a purely physical one: we know that as iron sharpeneth iron, so does the countenance of a man his friend, but it is an age of physical study, and it seems as if to this, at first sight purely mental action, we had also a physical basis. It may be added, also, that as it is clear that the germs of life in the atmosphere set in motion fermentation and analogous decompositions, they will probably keep up in the blood an analogous agitation. In some cases that movement is found to be productive of offensive action, such as putrefaction, in others an action giving rise to a smell such as worts, which is pleasant, and these analogies are fairly applied to ourselves, as probably influenced for good and for evil by these minute bodies. Of course, some one may say that all are products of decomposition, but that is not a reply. It is fair to suppose that as some of the germs in the air produce evil, so others may have a positively beneficial influence on health, physical in the first place, but not forgetting the mind.

It is to the avoidance of evil more than the attainment of good that this society devotes itself. It desires to avoid the consequences of the breathing of impure air or the use of impure food or drink, and the many evils arising from the want of cleanliness and crowding.

I have spoken of the many varieties of bodies which may be found in our atmosphere, and which may come from space into it or rise from the ground, but I have dwelt long on none. Details, of course, must have lectures for themselves. I have shown you that evils supposed to be abstract and beyond our control are by inquiry proved to be traceable to material objects, however small, and their origin being known they can be avoided; and I have given you material to think upon regarding a peculiar *class which is entirely out of our influence*. I have touched very lightly on the actual title of the lecture, but endeavoured to arrive at it by a series of steps, leaving the description out when the arrival was made, because who can describe the invisible. I might, however, have supplied you with a few more proofs or analogies, but this may be taken as the first part: and, in any case, we must always remember that that which is unseen to-day may be seen to-morrow.