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EPIDEMICS

EXAMINED AND EXPLAINED:

OR,

LIVING GERMS

PROVED BY ANALOGY TO BE

A SOURCE OF DISEASE.

BY

JOHN GROVE, M.R.C.S.L.

AUTHOR OF "SULPHUR AS A REMEDY IN EPIDEMIC CHOLERA."

LONDON:

JAMES RIDGWAY, PICCADILLY.

MDCCCL.

"The tendencies of the mind, the turn of thought of whole ages, have frequently depended on prevailing diseases; for nothing exercises a more potent influence over man, either in disposing him to calmness and submission, or in kindling in him the wildest passions, than the proximity of inevitable and universal danger."—*Hecker's Epidemics of the Middle Ages.*

"The grand field of investigation lies immediately before us; we are trampling every hour upon things which to the ignorant seem nothing but dirt, but to the curious are precious as gold."—*Sewell on the Cultivation of the Intellect.*

TO

BENJAMIN GUY BABINGTON, F.R.S., M.D.,

PHYSICIAN TO GUY'S HOSPITAL,

AND

PRESIDENT OF THE EPIDEMIOLOGICAL SOCIETY,

ETC. ETC.

THESE PAGES ARE, BY HIS KIND PERMISSION,

Respectfully Dedicated,

BY HIS OBLIGED AND FAITHFUL SERVANT,

THE AUTHOR.

PREFACE.

The following pages have been written with a view to render some aid in establishing a sound and firm basis for future research, on that absorbing topic, the Causes and Nature of Epidemic Diseases.

The amount of information already published on Fevers, on the Exanthemata, and on the Plague, is truly astonishing, and the more so when it is considered, that at present no rational account or explanation is given of the causes of these affections.

It appears to me but reasonable to suppose that as every thing on this earth has been created on a wise and unerring principle, Epidemic and Infectious Diseases are only indicative of some serious errors in our social arrangements and habits. The dangers and misery brought upon us by disease, may, as shewn by Dr. Spurzheim and Mr. Combe, be warnings against the infringement of the natural laws.

Indeed, what is more rational than to suppose that the Seeds of Disease are coeval with the fall of man. His first disobedience brought death:—that his subsequent errors should hasten its approaches is not to be marvelled at. The undetected murderer, though he may escape the punishment human justice would inflict upon him for his delinquency, suffers a penalty in the tortures of conscience, infinitely more horrifying than the most ignominious death. The law of nature is triumphant.

No less certain, though after a different manner, are the consequences of minor forms of disobedience. It is so ordained, that certain diseases shall arise, under peculiar conditions, which may have been brought about by a train of causes, easily imagined, and difficult to be explained, but all having their origin in the vices and errors of man in his moral and social relations.

If man neglects the cultivation of the ground; with rank vegetation, the germs of fever will invisibly grow and multiply; if he harbours that which is rotten and corrupt, he is himself consumed by those agents destined to remove the rottenness and corruption; it is a part of the law of nature that there should be active and energetic agents for this purpose. The seeds of disease, like the seeds of plants, may be shewn to have their indigenous localities; like them they may be spread and multiplied; like them they may lie dormant, and after awhile spring as it were into active existence; like them, when the soil and other conditions favour, they are ever ready to make their appearance. And this is the law, the germs of all disease exist, and have existed. Despise the dictates of nature, be careless of yourself and those around you, neglect to use the means which a noble intelligence has placed at your command, and above all, transgress the laws of God, then will disease pursue and attend you, as the conscience of the murderer pursues and attends him until he is finally cut off.

His wants and necessities, his sufferings and privations, are the basis of the intellectual progress of man. The wonders of Omnipotence are revealed through the whirlwind, the storm, the pestilence, and the famine.

The constructive and perceptive faculties of man have been developed by the necessity of protecting himself from injury by winds and rains; his intellectual faculties have been cultivated, by the sufferings of disease having led him to the study of organization and life, to discover the cause,—and to chemistry, and other sciences for the cure of his ailments.

Famine and distress have aroused his emotions, and softened down his asperities, so that what appears at first to be the infliction of a Curse without Pity, is in reality a Judgment with Mercy.

It occurred to me, that on the formation of the Epidemiological Society, the first question for consideration should be, What is the nature of those agents, which induce Epidemic Diseases? are they composed of animate or inanimate matter? In other words, do the manifestations of

these diseases exhibit the operations of living or of chemical forces.

Having, in my study, dwelt on the subject with an earnest desire to find the truth, I put the suggestion, with my ideas, before the public to reject or receive them. If they be rejected, I can but think a full discussion of the enquiry will lead to the most important results. If they be received with favour, I doubt not others, with more ability, will take up the strain and resolve the discords into harmony.

J. G.

Wandsworth, September, 1850.

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INTRODUCTION.

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It is one thing for a man to convince himself, but a very different thing to be able to convince others.

I am not now speaking of a conviction arising from the impression made by a few startling facts, nor of one forced on the mind by early prejudices, or by the dogmas of the schools, but of a conviction arising from careful enquiry.

In the course of that enquiry, the collector of facts, sees their relations to the idea in his mind, in a multiplicity of ways, from their remaining, each, as one succeeds the other, an appreciable time on the sensorium, and undergoing a certain process of comparison and relation, with all other facts and ideas which have been previously stored up. As the materials for an edifice which have been shaped and prepared in accordance with the completion of the design, so do the facts and ideas which are accumulated in the mind, become shaped and prepared for the elimination of a {2}
truth. The ultimate design of the architect can no more be conceived by the examination of the framework of a window, or the capital of a column, than the whole truth of a proposition by the examination of separate facts; the whole must be conceived and all the relations of all the parts thoroughly understood, before the architect can be comprehended or the harmony of his design appreciated.

The process of thought in the minds of the architect, and in the framer of a proposition, is never exactly the same as in those who contemplate and examine their completed works. Much may be done, however, by both to aid others in comprehending them. The more accurately they keep in view the course their minds have taken, the more readily will their descriptions be understood.

To simplify the elements of our knowledge is to give others a ready access to our thoughts.

To arrange the course of our ideas in harmony with the elements of our knowledge should be the

end of all writing, as it is the only means of multiplying knowledge. {3}

It is not the mere accumulation of facts which constitutes science, any more than a collection of building materials constitutes a house, it is the arrangement and adaptation of the means to the end by which the house becomes built and science cultivated.

These reflections have been suggested by the circumstance that for the last 3000 years and upwards, Pestilences have at certain intervals done their work of destruction, and opened the springs of misery to untold millions, and yet I see not that we are much further advanced as to the knowledge of the cause of these inflictions than the Jews in the time of Moses. In the Levitical law, as I shall have occasion more particularly to shew hereafter, were directions specially given in reference to the plague of leprosy; what means should be adopted for the cure of the disease, and for preventing its extension, and moreover pointing very significantly to certain facts having connexion with the cause of the affection. Since that time historians generally, and medical writers in particular, have diligently recorded their observations and accumulated facts, on the various desolating plagues which have afflicted mankind. Some of these men have grappled with {4} the whole subject, and endeavoured to shew the presumed relation of the supposed causes in all their intricacies, but it is hardly necessary to say that all have signally failed in their attempts to furnish us with any practical information.

Satisfied in my own mind that the whole subject is beyond the labour of one man, and impressed with the belief that the basis of the enquiry is in anything but a satisfactory state, I have applied myself entirely to the study of the groundwork only, as the primary proceeding for a solid superstructure.

The days are past, when imaginary spirits, ethers, and astronomical phenomena, were believed to have any essential influence over our destinies in a physical point of view; we have therefore to deal with *matter* in some form or other.

The question, therefore, which I have proposed for enquiry, is, whether the matter which causes epidemic and endemic diseases, exhibits the properties of inorganic or organized matter.

The properties and qualities of organized bodies, as well as those of inorganic matter, need but {5} be stated, and in some instances we may picture to ourselves the object, without having seen it, and not be very far from a true conception. But for this purpose a clear and definite idea must be previously formed, and have taken possession of the mind, of the great general divisions of objects in the material world.

Having made these preliminary remarks, I have suggested a certain mode of procedure in making enquiries of this kind, not perhaps in strict accordance with logical systems, but on the principle of nature's operations in our own minds, which appears to me, when reduced to a systematic and simple form, to be sufficiently clear and strict for synthetical application, and so concise as to be usefully and practicably applied.

In endeavouring to establish a theory for the explanation of extraordinary phenomena, there are certain rules which should guide us in the thorny and treacherous path of speculation. But these rules readily flow from the train of thought, and if we examine our own minds during their operations, we shall find that the following is the course of our instinctive reflections. It is a {6} course we adopt as the test of theories when formed, and is a guide in all cases for their construction.

We first commence with an idea, which exists in our minds in the form of a proposition: then the following rules naturally suggest themselves:—

1. The probability of the value of our proposition from inference.

2. The number and value of facts to support the proposition.

3. The reasonableness of the application of the facts to the inference.

4. What amount of information in the form of results can be produced in proof of the tenableness of the proposition.[1]

In illustration of the value of these rules the history of Dr. Jenner's discovery affords an appropriate example. To use the words of Dr. Gregory, "he appears very early in life to have had {7} his attention fixed by a popular notion among the peasantry of Gloucestershire, of the existence of an affection in the cow, supposed to afford security against the Small Pox; but he was not successful in convincing his professional brethren of the importance of the *idea*."

The popular notion of the peasantry originated the idea in Jenner's mind, and it became fixed there as a proposition.

1. He commenced his enquiry by observing that the hands of milkers on the dairy farms were subject to an eruption, and he *inferred* that the notion of the peasantry bore the stamp of probability, which strengthened the idea in his mind and gave force to the proposition.

2. His next step was to accumulate facts; he found on enquiry that the persons engaged on these farms in milking, possessed an immunity from Small Pox to an extent sufficient to strengthen the value of his proposition.

3. The reasonableness of the application of the facts to the inference is clear from the

coincidence that the eruption on the hands of the dairy people bore a striking resemblance to the Small Pox, and as this disease does not usually occur twice in the same individual, the inference was most reasonable that this eruption protected the people from Small Pox. {8}

4. We have but to take the almost universal adoption of vaccination, and its acknowledged prophylactic powers against the propagation of Small Pox to shew the application of our fourth rule.[2]

Between the conception of the idea and the accomplishment of Jenner's designs, vaccination seems to have undergone an incubation of nearly twenty years. During that period, with an energy and perseverance only to be obtained by confidence, did this great man brood over and elaborate his idea; and well might the 14th day of May, 1796, be styled the birth day of vaccination, for on that day was a child first inoculated from the hands of a milker. {9}

In adopting the above method I have endeavoured to bear in mind M. Quetelet's observations on the requirements necessary for medical authorship; he says, "All reasonable men will, I think, agree on this point, that we must inform ourselves by observation, collect well-recorded facts, render them rigorously comparable, before seeking to discuss them with a view of declaring their relations, and methodically proceeding to the appreciation of causes."

CHAPTER I. {10}

IS IT PROBABLE THAT EPIDEMIC, ENDEMIC, AND INFECTIOUS DISEASES, DEPEND UPON VITAL GERMS FOR THEIR MANIFESTATIONS?

It is, I believe, almost universally considered that Epidemic, Endemic, and Infectious diseases, originate from some imaginary poisons of a specific nature, each disease having its own peculiar poison. That this conception should have taken possession of the minds of men, is most natural from the symptoms which characterize these diseases, but when we come to enquire into the nature of these agents, or supposed poisons, we are at once struck with the idea that they exhibit one peculiarity which separates them in a marked manner, from those poisons with which we are familiar; for the poisons of Small Pox, Measles, Scarlet Fever, Hooping Cough, Fever, &c. possess the power of multiplication, or spontaneous increase, a property which attaches only to the organic kingdom, and is never known in the inorganic kingdom. The source of most of the poisons is to be found among mineral or vegetable products. A mineral in combination with an acid or oxygen may become a poison, and nitrogen in various combinations with oxygen, hydrogen, and carbon, or with carbon alone, may become a poison; these combinations are, however, in most instances the products of vegetable life, others again are obtained from the animal kingdom, such as the poison of the serpent, &c. but in all of these instances, there is not one in which the power of self-multiplication is to be found. {12}

We are, therefore, constrained to admit that this feature, which distinguishes poisons, is one well worthy attentive consideration. The varieties of poisons may be classified into those which act topically as escharotic poisons, those which act chemically on the blood, and those whose effects are manifested in inducing a speedy annihilation of organic or vital action, as in the case of hydrocyanic acid, which is supposed specifically to affect the nervous centres from which originate the vital manifestations. It is rather remarkable that the vital poisons (as I will call them for distinction), seem to have their appropriate locality in the blood, they do not primarily affect one organ more than another, all the effects we witness resulting from them are to be traced progressively from the blood to other parts of the body. When a person is inoculated with small pox, a very minute portion (indeed it is impossible to say how minute it may be) is sufficient, when absorbed, to excite a certain train of symptoms, all due to absorption of the materies of the disease, and the process by which that materies arrives at maturity, is that known in the vegetable world as the fructification; this process of fructification is a process of development and increase. {13}

I here may repeat that among all the poisons known, constituted as they are of various combinations of elementary matter, they are without exception destitute of the power of development or increase. Now, it is pretty accurately known what amount of these poisons is necessary to produce their effects on the living body; we can say how many drops are sufficient of hydrocyanic acid of Scheeles strength, to destroy a man instantaneously. Again, how many grains of arsenious acid are sufficient to induce such an inflammatory condition of the stomach and intestine as will end in death, and how many grains of morphia, will bring about a fatal coma, —but who shall say the amount of the vital poisons necessary to produce their results? It far exceeds the limit of conjecture, to what extent the dilution of miasmatic or contagious matter may be carried, and the poison yet be capable of committing in a short time the most frightful ravages.

We may fairly then infer, that if a quantity of matter inappreciable in amount be sufficient to exhibit the characters of growth and increase, that it is endowed with the properties of vitality. That the poisons of scarlet fever, of measles, and of small-pox have this power of growth and increase, is as much a matter of universal belief as that "the sun will rise and set to-morrow, and that all living beings will die." {14}

This power of individual increase, or reproduction, is the very summit of vital manifestation; indeed Coleridge, in his Theory of Life, (in which he says, "I define life as the *principle of*

individuation, or the power which unites a given *all* into a whole that is presupposed by all its parts,") places reproduction in the first rank, and expresses his hypothesis thus: "the constituent forces of life in the human living body are, first, the power of length or reproduction; 2nd, the power of surface, or irritability; 3rd, the power of depth, or sensibility—life itself is neither of these separately, but the copula of all three."

Extensive research is not required to shew that many thinking men believe in the existence of living organic beings, as the elements of contagious and epidemic diseases; the idea indeed seems to flow spontaneously in that direction. Whenever thought, and enduring contemplation, have been concentrated on the subject, the result appears to have been the same, a firm conviction in each individual mind that a vital force must be in operation; or as Schlegel would define it, "a living reproductive power, capable of and designed to develope and propagate itself."—"Its Maker originally fixed and assigned to it the end towards which all its efforts were ultimately to be directed."

Referring further to beings having the property of reproduction and propagation, he says, (using the word nature here evidently as the vital principle for want of a better term,) "Nature indeed is {15}
not free like man, but still is not a piece of dead clockwork. *There is life in it.*"—"Thus we know that even plants sleep, and that they too as much as animals, though after a different sort, have a true impregnation and propagation."

When Schlegel wrote this, how little could he have imagined the intricacy of this proceeding among the lower forms of vegetation. It has been shewn by Suminski, and verified by many others, that the mode of impregnation, and the period at which it occurs in the ferns, do not at all correspond to the general notion on this subject. He has discovered in the early development of the frond of ferns certain cells, which he denominates antheridia, or sperm cells; these contain in their cavity a number of subordinate cells, each containing a spermatazoon. At a certain period of the progress of the frond, the parent cells become ruptured and liberate the spermatoza, these move about in a mucilaginous fluid, which bedews the inferior surface of the frond, and become the means of impregnating the germ cells, or pistillidia, with which they readily come in contact. Thus the process of impregnation in these plants occurs during the germination, or what corresponds to the period of germination in the seeds of exogenous and endogenous plants.

I have referred to the discovery of Suminski in this place to recal to the mind the great and {16}
incomprehensible wonders of creation, for who could conceive it possible or feasible that even for the impregnation of an inferior vegetable, animal life should form an indispensable and essential appurtenant of the process. Truly may we say with Coleridge, of plants and insects, "so reciprocally inter-dependent and necessary are they to each other, that we can almost as little think of vegetation without insects, as of insects without vegetation."

I will make but two more quotations on the supposed vital character of the germs of disease. "That the air and atmosphere of our globe is in the highest degree full of life, I may, I think, take here for granted, and generally admitted. It is, however, of a mixed kind and quality, combining the refreshing breath of spring with the parching simooms of the desert, and where the healthy odours fluctuate in chaotic struggle with the most deadly vapours. What else in general *is the wide-spread and spreading pestilence*, but a living propagation of foulness, corruption, and death? Are not many poisons, *especially animal poisons, in a true sense, living forces*?"—Schlegel.[3]

It were useless to multiply quotations to shew that the opinions here entertained are matters of {17}
general belief among thinking men.[4] I will at once then conclude with an observation of Dr. C. J. B. Williams: he puts the question, "Does the matter of contagion consist of vegetable seeds? Are infectious diseases the results of the operations and invasions of living parasites, disturbing in sundry ways the structures and functions of the body, each after its own kind, until the vital powers either fail or succeed in expelling the invading tribes from the system?"

And this expression, the seeds, is an universal expression, it is a "Household Word" in connexion with disease. That it has obtained this position in the popular vocabulary is alone a proof of the applicability of the term to the thing intended to be signified. Popular notions, as we have seen in {18}
the case of Jenner's discovery, are not to be unheeded. An instance occurs to me, it was a popular belief, that in acne punctata, the matter of a sebaceous follicle, was itself, when pressed out, a worm, the dark portion which results from the accumulation of dust upon the matter at the mouth of the follicle was supposed to be the head of the maggot, as it was called; subsequent observation, however, has proved that though this matter is not a worm, it contains an animal within its substance, the Acarus folliculorum.

The popular notions found among savage tribes as to the efficacy of certain remedies in the cure of disease have been the means of furnishing us with some of our most valuable medicines, indeed it is almost impossible to say whether originally man did not derive his remedies from the herbs and trees by an instinctive faculty impelling him, as it does the animals when in a state of liberty and with freedom of range, to seek certain plants as they avoid others.

It is well known that animals when indisposed will find out some spot as if almost led to it by a visionary guide where the "healing plant" is to be discovered. I am told that sheep have this faculty, and that they will, when affected with the rot, feed upon some plant when they can discover it, which eradicates the disease.

Almost every one is familiar with the fact that cats and dogs will crop herbage and eat it; I have

seen them frequently leave the house and proceed to the grass in the most business-like manner, partake of some quantity, and quietly return. {19}

A close observer of diseased animals might obtain some useful information by noticing the plants cropped by them while in that condition. The observations should be made in a variety of districts in consequence of the uncertain distribution of some even of the most commonly scattered plants; in one year they may be abundant, but in another they may be almost entirely absent from the same spot.[5]

Were it only on the fact of reproduction, I would be contented to take my stand that the force of life is the indwelling power of pestilential matter. Reproduction is a law of nature, and the law of nature is the law of God. And where do we find He prevaricates with us? The more we study His laws the more harmony and perfection we find; what is seeming confusion in the ignorance of to-day, is order in the knowledge of to-morrow. If any one ignorant of the law which regulates the diffusion of gases were told that a heavier gas would ascend contrary to its specific gravity {20} through the septum in a vessel containing a lighter gas above the heavier, he would naturally doubt your assertion, and say, "that is contrary to the law of gravity;" but explain to him the principle by which this comes about, and the objects of the law; the order and beauty of the design become manifest. But this is no equivocation, it is evidence there, that subordinate laws exist and nothing more. It has never been found that men have gathered "grapes of thorns and figs of thistles," nor has it ever been discovered that inanimate matter multiplies itself. The seed of disease "is within itself," multiplying and propagating itself; whether it formed a part of creation at the beginning or not, is rather a question to be solved by divines than physicians. When we know, however, the latency of seeds and even of entire plants, and that they may be dried and remain so for years yet being brought again into conditions adapted to their active existence, they, as it were, revive from their sleep, and renew again their reproductive properties: can we wonder if, in the great scheme of nature, existences new to mankind should make their appearance? When the New Zealander saw the surface of his ground producing to him unknown plants, and the skins of his children generating peculiar eruptions, and each propagating its kind, would he look, think you, to the wood or the stones, the air or the water,—for the solution of the mystery? No, he would naturally say these people brought the *seeds* with {21} them. From the property of reproduction possessed by these forms of matter, we infer the value of the proposition.

CHAPTER II. {22}

THE NUMBER AND VALUE OF FACTS TO SUPPORT THE PROPOSITION.

———

SECTION I.

ON REPRODUCTION.

It is inferred that the proposition, "*the matter which operates in the production of Epidemic, Endemic, and Infectious Diseases, possesses the property of vitality*," we proceed now to the enumeration of those facts which further elucidate this subject.

The facts must necessarily be such as illustrate the identity of properties in the imaginary germs, that are known to exist in demonstrable germs: we take therefore the law of reproduction to be to life, what the law of attraction is to gravitation.[6]

But further; do those matters which engender disease furnish to our minds the properties {23} inseparable from life in the abstract? Though the faculty of reproduction is essentially an evidence that the thing which reproduces its kind must be a living body, yet it is only a property or power of living beings and is not itself life, it therefore is necessary to establish the fact that the *materies morbi* not only has the power of reproduction, but also those properties which in the abstract will prove as far as demonstration can go, that it has the essential properties common to all living bodies.

I must again quote from Coleridge, he says: "By life I every where mean the true idea of life, or that most general form under which life manifests itself to us, which includes all its other forms. This I have stated to be the *tendency to individuation* and the degrees or intensities of life, to consist in the progressive realization of this tendency. The power which is acknowledged to exist {24} wherever the realization is found, must subsist wherever the tendency is manifested. The power which comes forth and stirs abroad in the bird, must be latent in the egg."

The tendency to individuation cannot be more strongly marked than in the simple experiment of vaccination: we insert a small particle of the so-called vaccine lymph under the skin, and by this means we multiply to an enormous extent, the power which, in the first instance, we had in the form of minute corpuscles in a dry and apparently inert state; nevertheless, though in this condition there must have existed the tendency to individuation or multiplication of individual existence, and the germs are here to their active existence, as seen in the development of the vaccine vesicle, what the egg is to the bird,[7] as described above; we may, therefore, say that the power which exhibits itself in the production of a vaccine vesicle, must have been latent in the dried matter. It is the opinion of Muller that the entire vital principle of the egg resides in the {25}

germinal disk alone, and since *the external influences which act on the germs* of the most different organic beings are the same, we must regard the simple germinal disk, consisting of granular amorphous matter, as the potential whole of the future animal, endowed with the essential and specific force or principle of the future being, and capable of increasing the very small amount of this specific force and matter, which it already possesses, by the assimilation of new matter.

After speaking of inanimate objects, Dr. Carpenter says; "and what compared with the permanence of these is the duration of any structure subject to the conditions of *vitality*? *To be born*, to grow, to arrive at maturity, to decline, to die, to decay, is the sum of the history of every being that lives; from man, in the pomp of royalty, or the pride of philosophy, to the gay and thoughtless insect that glitters for a few hours in the sunbeam and is seen no more; from the stately oak, the monarch of the forest through successive centuries, to the humble fungus which shoots forth and withers in a day."

To be born, signifies the faculty of reproduction existing or having existed in an antecedent being to that one born, and also that itself possesses equally a like power. To be born, is the first expression which must be used in speaking of the faculties or properties of living beings as independent existences, the annual formation of buds, trees, and shrubs, is a multiplication of the species; the coral and various budding polypes increase by this process, indeed what is the seed {26}
of a plant, or the egg of a bird, or the ovum of mammalia, but cast off buds; in all, the new being was originally a portion of its parent, and if we examine the ovary of the vegetable, the bird, or the mammal, can we find any expression more fitting to designate the process than that of budding. To be born then, is the evidence of an act of one living being, and the commencement of a series of vital phenomena in another, but all these are subsequent to reproduction, and constitute another chain of vital acts, all tending to a similar result, the multiplication of the species.[8]

Now, whether we apply the philosophical language of Coleridge, or the language of observation of Muller, in confirmation of the doctrine here inculcated, we arrive at the same point.

Do we not witness in the newly formed vaccine vesicle, an increase of the specific force and principle? We certainly have acquired by the process of vaccination a manifold multiplication of power, and is there not also assimilation of new matter in which this power resides? And does not {27}
every particle of this new matter contain within itself the same force and principle, as existed in that which generated it?

"We revert again to potentiated length in the power of magnetism (reproduction); to surface in the power of electricity, and to the synthesis of both or potentiated depth in constructive, that is chemical affinity."[9]

Some may be at a loss to conceive, at first, how irritability may be considered a property of all vegetable matter; that it does exist in some vegetables is certain, but that it does exist in all living beings is equally certain;[10] the term, however, which would appear more appropriate when that irritability does not exhibit itself in an appreciable form, is *impressibility*. Irritability, as commonly understood, is seen in its highest condition in muscular tissue; but "the irritable power and an analogon of voluntary motion first dawn on us in the vegetable world in the stamina and anthers at the period of impregnation."—"The insect world is the exponent of {28}
irritability, as the vegetable is of reproduction."

The property of irritability attains its acme in man, the most highly organized of all beings; and its gradations pass downwards through the whole scale of animate creation; not so reproduction, for this faculty observes the very opposite direction, for in plants a single impregnation is sufficient for the evolution of myriads of detached lives.

Reproduction is a fact, it is an essential property of life, and is a reality to us from observation; but irritability is not so tangible and demonstrable a property. We nevertheless may assume its universality, from the circumstance that we lose sight of it by imperceptible degrees; the irritability of the sensitive plant is as much irritability as that of the highly organized muscle; but because the faculty evades our perception, "in tapering by degrees, becoming beautifully less," we have no reason for pronouncing its total extinction at any one point of the vegetable kingdom, [11] any more than we should have in saying that we see the end of the earth, when describing {29}
the extent of our vision as we stand on the sea shore. The extreme limit of our vision is the tangent of the circle in reference to our visual organs; but how many tangential points there may be beyond, it is impossible to say without knowing the dimensions of the circle.

I think we are now in a condition to assume, as far as abstraction will conduct us without proceeding to an extreme length, that the *materies morbi*, or, as I will now call them for the sake of clearer distinction, *semina morbi*, possess those properties which in the abstract are common to all living beings.

Another argument strikes me as capable of adding further strength to the proposition. We need but be told that a small piece of iron was placed in a certain position with regard to another piece of iron, and that the smaller piece moved through a given space and became attached to the larger, to infer that magnetic force was in operation. Supposing this magnet then to be folded in paper, and that it be promiscuously placed near a compass, the deflection of the needle would {30}
indicate that some object in the vicinity was the cause of the deflection; we may farther try what

positions the needle takes by varying the position of the packet, and thus point out which is the north and which the south pole of the screw of paper. If we may consider attraction then to be to gravitation what reproduction is to life, we do not err in saying in the one instance that there is a living being, and in the other there is a magnet.

The nebular theory, from which some astronomers made the foundation of many speculations, came with so much interest to our minds that the fascination could not be resisted. It was most delightful to revel in the imagination that we possessed a key to the mode of formation of the starry hosts, and when speculation had taken its extreme limits in the "Vestiges of the Natural History of Creation," and the nebulæ had served as the ground work of a gigantic scheme, Lord Ross's monster telescope swept the heavens of its cobwebs. We can imagine this great promoter of science saying to us, Gentlemen, the clouds which have obscured you, are composed of myriads of stars, and comprise systems as vast and as luminous as our own, had you but power of vision to discern them. A new light thus appeared to philosophers, and though no great practical results may flow from the discovery, it is instructive from the fact that the imperfectly aided or unaided vision, should not limit legitimate inference. The nebulæ before Lord Ross's discovery {31}
were to the astronomer what the materies of epidemic and infectious disease are to medical men. In the absence however of a giant microscope to reveal such great truths, we may yet dimly shadow them by the light of our reason. It was predicted in 1849 that minute vegetable germs, in all probability all of the same type, were the agents producing epidemic and infectious disease. In 1850, Mr. Oke Spooner says,[12] "On examining the matter of Small Pox and Cow Pox in every {32}
stage, he finds its essential character to consist of a number of minute cells not exceeding the 10,000th part of an inch in diameter: being about one-fourth smaller than the globules of the blood, containing within their circumference many still more minute nuclei, and presenting beyond their circumference bud-like cells of the same size and character as those contained within the circle."

Should these observations made by Mr. Spooner turn out to be correct, they will but fulfil my anticipations. Then again shall we see the same application of imperfect vision to the limitation or temporary obstruction of solid and determinate knowledge.

We may reasonably expect that these bodies, discovered by Mr. Spooner, should be the elementary matters of disease. Their existence was predicted from the probability that living matter must be the agent; moreover, that this matter when discovered would be cellular, most {33}
probably resembling the yeast plant as described by Mr. Spooner.

It was predicted that a planet would be discovered in a certain position in the heavens, because the perturbations of a comet indicated an attracting body in the path of the eccentric wanderer; the prediction and the fulfilment were almost simultaneous.

SECTION II. {34}

HISTORICAL NOTICE OF EPIDEMIC DISEASES.

The earliest notices we have of Pestilences are contained in Holy Writ. The plagues which smote the Egyptians in the time of Moses are not unworthy some comment here. Of those ten plagues, four out of the number were due to the miraculous appearance of myriads of the lower animal tribes, in three instances of insects,[13] viz. lice, flies, and locusts; in the fourth, when Aaron stretched forth his hand with his rod over the streams, over the rivers, and the ponds, frogs came up and covered the land of Egypt. In these instances living beings are made the instruments in God's hand for the punishment of the wicked. These plagues include the second, third, fourth, and eighth. The first plague is mentioned as a conversion of the waters into blood. Now if we may take this expression as being literal, there is no reason to suppose that this blood differed in any respect from ordinary sanguineous liquid; we therefore may assume, as the blood is every where in Scripture spoken of as the *life*, that this fluid was endowed with vital properties.

The fifth plague is described as a murrain among beasts; and the sixth, as exhibiting itself as "a {35}
boil breaking forth with blains, upon man and upon beast."[14] Now these affections bear a resemblance to the diseases known to us at the present day through authentic records. The Black Death of the 14th century affords in its history but too awful a picture of the horrors of such pestilences. In the tenth plague, the smiting of the first-born, we are not told by what means it was brought about; but we have something even here to lead us to conjecture. In the second visitation of the Black Death, there were destroyed a great many children whom it had formerly spared, and but few women. The seventh plague of hail is within our conception; as is also that of darkness, the ninth plague.

It is not a little remarkable that of the ten plagues, seven of them depended upon agents intelligible to our comprehension; we can conceive of the invasion of a country by myriads of {36}
loathsome insects and reptiles, and can imagine the wrath of an offended Deity directing the force of a supernatural storm of hail upon a disobedient people; and we can conjecture, though faintly, the consternation of human nature on being subjected to a total darkness of three days' duration, when we consider *that* darkness has been described, as "a darkness that might be felt."

From this abstract we discover that the three plagues whose causes we cannot understand, or rather upon which no light has been thrown by Scripture, bear analogies to those which we recognise, in the writings of modern authors, as fearful pestilences.

It is now our province to reflect on the causes supposed to be in operation in the three instances, which become naturally separated from the rest.

We are told that a murrain appeared among the cattle, without any preliminary step. When the blains broke out upon man and beast, Moses had been previously directed by the Almighty to take handfuls of the ashes of the furnace, and sprinkle them towards the heaven in the sight of Pharaoh. "*And it shall become small dust in all the land of Egypt*, and shall be a boil breaking forth with blains upon man and upon beast, throughout all the land of Egypt."

Another coincidence, in connexion with subsequent pestilences, arrests the attention, on the subject of the mysterious appearance on these occasions of matter resembling dust being {37} prevalent about the houses, and on the clothes of the people. Clouds also, and showers of dust-like particles, were not of infrequent occurrence. Indeed, in the summer of 1849, during the progress of the Cholera, several phenomena of a similar nature were observed and authenticated; I myself can bear testimony to one instance of the kind. It was observed by many persons in my neighbourhood after the passage of an ominous and lurid cloud, that as they walked their clothes became covered with a singular dust-like matter of very peculiar appearance. That this phenomenon was not destitute of significance may be gathered from the fact, that on the night of that day several severe cases of Cholera occurred, though our village had been comparatively free for ten days.

Hecker, in writing on the Black Death says, the German accounts expressly speak of a "thick stinking mist which advanced from the east,[15] and spread itself over Italy; there could be no {38} deception in so palpable a phenomenon." It is not unworthy of mention, that in the East successive invasions of locusts "which had never perhaps darkened the sun in thicker swarms," preceded the great outbreak of this disease, for they left famine in their train.

From 1500 to 1503 in Germany and France, during the prevalence of the sweating sickness, spots of different colours made their appearance, "principally red, but also white, yellow, grey, and black, often in a very short time, on the roofs of houses, on clothes, on the veils and neckerchiefs of women, &c." Blood rain is also mentioned as having occurred at this time, which consisted of the aggregation of minute particles of red matter.

In the seven plagues, miraculous operations of the Deity consisted in the unusual manifestation of phenomena, but which in their effects are recognizable as of clear and definite import. The miracles here are,—in the *mode* of producing the swarms of frogs, locusts, &c. but they are manifest and unmistakeable *causes* of plague and famine; in the other three, on the contrary, we witness only the effects, the causes are hidden from us; we may, therefore, as in current events, legitimately investigate the subject, and what better course can be adopted than that which classifies the traditionary past with all subsequent history. Presuming such a method of research to be admitted, I have assumed that as the *causes* of the seven plagues have been distinctly {39} given, the others, though only mentioned in their effects, were due to causes of a nature in some way to be compared with their concomitants, that is to say, if a special intervention of the Deity brought about a miraculous appearance of frogs, lice, &c. there is but little reason to doubt that some other agent was miraculously multiplied and concentrated to induce the murrain, engender the blain, and smite the first-born: as if to lead us into this enquiry, on the visitation of the blain in man and beast, the Bible History tells us that Moses threw ashes of the furnace, which became a dust throughout all the land of Egypt; we cannot imagine that this simply as ashes could have caused the blain, we may conclude that by some special miracle, either the ashes were converted into a specific form of matter capable of inducing the effects recorded, or that an independent septic matter was generated for the purpose. If the latter, the act of throwing the ashes of the furnace into the air may have been intended to signify that the extremely minute division of the particles when thus cast into space, typified the inscrutable and hidden nature of the matter endowed with such marvellous properties.[16]

Further on in the book of Leviticus are passages which I cannot forbear transcribing, for they {40} point out to us most indubitably a line of enquiry in reference to diseases of a contagious nature.

"The garment also that the plague of leprosy is in, whether it be a woollen garment, or a linen garment, whether it be in the warp or woof, of linen or of woollen, whether in a skin, or in any thing made of skin, and if the plague be greenish or reddish in the garment ... it is a plague of leprosy, and shall be shewed unto the Priest, and the Priest shall look upon the plague and shut up it that hath the plague seven days; and he shall look on the plague on the seventh day; if the plague be spread in the garment, either in the warp, &c. ... the plague is a fretting leprosy, it is unclean. He shall therefore burn that garment ... wherein the plague is, for it is a fretting leprosy; it shall be burnt in the fire. And if the Priest shall look, and behold, the plague be not spread in the garment ... then the Priest shall command that they wash the thing wherein the plague is, and he shall shut it up seven days more: and the Priest shall look on the plague, after that it is washed: and behold if the plague have *not* changed his colour, and the plague be not spread, it is unclean; thou shalt burn it in the fire; it is fret inward; whether it be bare within or without. And {41} if the Priest look and behold the plague be somewhat dark after the washing of it, then he shall rend it out of the garment ... and if it appear still in the garment either in the warp or the woof ... it is a spreading plague: thou shalt burn that wherein the plague is with fire. And the garment ... which thou shalt wash, if the plague be departed from them, then it shall be washed the second time and shall be clean."—Chap. xiii. 47-58.

Again in Deuteronomy. The curse for disobedience: "The Lord shall make the pestilence cleave to

thee until he have consumed thee from off the land.—The Lord shall smite thee with a consumption, and with a fever, and with an inflammation, and with an extreme burning, and with the drought, and with blasting, and with *mildew*, and they shall pursue thee until thou perish.—The Lord shall make the rain of thy land *powder* and *dust*: from heaven shall it come down upon thee until thou be destroyed."

It may be said, and I doubt not will be said, all this is unnecessarily dragging the sacred volume into an enquiry totally foreign to its general tenor; on the contrary, however, I maintain by that Book we are to learn the ways of God to man, and further, that no study can impress mankind with so awful, so terrific an idea of his responsible position, as that which leads him into the investigation of the causes by which the Almighty, doubtless in His wisdom, has thought fit at {42} various epochs of this world's history, to place man face to face with pestilence, famine and sudden death.

There is no man would less willingly than myself introduce profanely the revelations of Scripture. The observations here made are not, therefore, intended for light or heedless controversy; if they have a significance of any import, let them be alluded to in the same spirit with which they have been quoted; if they convey nothing for approval to the reader, let silence rest upon them. To those who would fain disregard my request, let me recall to their minds the veneration which from childhood I trust we have always felt on hearing or seeing those two words—Holy Bible.

It is yet to be determined, whether the greenish or reddish appearance of the garment spoken of, as being contaminated with the plague of the leprosy had any specific relation to the disease itself. The priest orders that the garment shall be shut up seven days, and on the seventh day, if the plague be increased, by which, of course, is meant if the greenish or reddish colour have increased, and from which we may gather that a power of spontaneous increase was possessed by the matter, such a result indicated a fretting leprosy, and the garment was to be burnt. Again, though there may have been no increase, but a persistence of the coloured matter after shutting up and washing the garment, it is to be burnt, for it is fret inward, signifying, that the germs of {43} the affection are still there, and may soon increase. Other rules follow in reference to the plague of leprosy, and the mode of deciding whether an article be unclean or clean is definitely laid down, but our purpose is served in mentioning the above, to shew that in the time of Moses the spontaneous increase of certain minute multiplying germs was supposed to have a close connexion with disease. It is equally clear, that the priests were aware by the order given them, that if the ordinary modes of purifying articles of clothing failed in their effect, the safest and surest method of destroying infectious matter was to resort to the practice of consuming by fire all materials capable of propagating an infectious malady.

The facts above noticed, accurately correspond to what we now know as applicable to the matter of infectious and contagious maladies. It is a rule, I believe universally adopted throughout the Poor-houses of this country, to put the clothes of all persons about to become residents in these establishments, into ovens, where they are submitted to a temperature incompatible with the existence of either animal or vegetable life. By this means all living matters are destroyed, but the fabrics and inorganic matters retain their properties intact. This simple proceeding, I am credibly informed, is an effectual preventive of contamination by articles of clothing, a desideratum of no small importance, when it is remembered that the diseases among the poor {44} owe much of their inveteracy to the accumulation of effete organic matters about their persons and clothes.

A few more observations are called for on the quotation from Deuteronomy, in which allusion is made to living matter being an agent in the production of disease. In the curse upon the children of Israel for disobedience, we read that they are to be smitten with mildew. No further information, however, is vouchsafed to us, nevertheless, we can conceive the wretched condition of those on whom the curse might fall. Again, we find in a continuation of this curse that the Almighty uses means such as He adopted in the sixth plague of the Egyptians. The ashes of the furnace became a small dust in all the land of Egypt, breaking forth with blains upon man and beast. In the curse of the Israelites the words are: "The Lord shall make the rain of thy land *powder and dust*: from Heaven shall it come down upon thee until thou be destroyed."

It might be conjectured that the absence of rain would be sufficient to account for the extinction of the people on whom the curse was pronounced, by the famine and drought necessarily attendant upon the loss of moisture. But this does not appear to be the meaning of the passage, for the powder and dust are mentioned as the agents of destruction; besides, in the continuation of the curse, the locust is to destroy the grain, the worm the grapes, and the olive is to shed his {45} fruit; we may thus take for granted that drought and famine are not to be caused by the showering of powder and dust, it must consequently be supposed that the effects of the dust in the instance of the Egyptians are to be compared and classified with those of the dust which smote the Israelites.

As far then as Sacred History conducts us in the enquiry, concerning the causes of pestilences, we gain encouragement in the belief that living germs are the active agents, for in the case of the leprosy, we have evidence of reproduction in connexion with infection, which, if our line of argument be tenable, amounts to demonstration; then, in the other instances of the plagues, by boils and blains, they distinctly bear comparison with the accounts given by profane writers, of the visitations of pestilences on the earth, subsequently to those mentioned in Scripture history.

This leads now to the consideration of recorded facts observed and noted during the various Epidemics in the early and subsequent periods of Man's History, as given by those on whom

reliance may be fairly placed.

Setting aside the uncertain information contained in the writings of the Chinese,[17] a people whose progress in the science and practice of Medicine has nothing to commend it (even as it is {46}
at the present day) to the notice either of the physician or the historian, unless it be to the latter as a mark of peculiarity both in a social and political point of view,—passing also over the Egyptians, the Arabians, and the Greeks,—and even Hippocrates himself, we are driven to the Romans for any authentic or precise notice of Epidemic Affections. It has been attributed to Hippocrates that he predicted the appearance of the Plague at Athens, and that when it was {47}
introduced into Greece he dispelled it, "by purifying the air with fires into which were thrown sweet-scented herbs and flowers along with other perfumes."[18] But little advantage can be derived from enquiries concerning the first appearance of any disease, for the probability of discovering the primary cause is certainly a hopeless case, if attempted by means of the writings {48}
of ancient authors, when it is recollected that with all the science and learning of the ancient Egyptians, the use of optical instruments was not comprised among the paraphernalia of their arts. The knowledge that was limited to the powers of natural vision, where the foundation of knowledge is based upon facts obtained through the aid of that penetrator of nature's secrets, the microscope, offers no advantages to the student of the present day.

To say that a disease commenced in the East and travelled westward, and at length found a habitation and a name in every part of the globe, is no more than to say that disease is coeval with the fall of man. The cause is as much hidden in the region of its birth, as in that where it sojourns for a time. The cause of the sweating sickness was as much a mystery in England as in all the other nations of Europe, which were visited by its devastating power. And these observations apply with as much force to one disease as another; for even our indigenous ague, originating in some places so limited that the shadow of a passing cloud may mark the boundary of its dwelling place, as inscrutably evades our vigilance, with all the appliances that art can bring to our assistance, in endeavouring to evoke its extraordinary properties under the cognizance of our senses.

If we weigh the air which carries the poison, or analyze it by the most delicate chemical tests, or take the weight of the atmosphere which is charged with it, or if we take the blood which carries {49}
the germs of the disease to the tissues of the body, and submit them after the work of destruction is accomplished, to the most rigid inspection, we can but exclaim,

> "These are Thy marvellous works!"

and confess our total inability to fathom the unbounded.

If then no practical advantage can accrue from investigating the writings of the ancients on these subjects, beyond comparing their historical statements with those of more recent date, our purpose will be served by occasionally embodying any remarkable observations of the former with those of the latter.

In proceeding with this course it were better to confine our minds chiefly to two diseases which appear from history to have been known from the earliest periods, these are the Plague and the Small Pox, mentioning other diseases only *en route*.

Passing then, to the sixth century of the Christian era for the first distinct and connected account of the Plague, it appears from a host of testimony, that the history of this disease, as given by Procopius, well merits our attention. Drs. Friend and Hamilton, in their Histories of Medicine, and Gibbon, in his History of Rome, are equally warm in their praise of Procopius: the latter says, he "emulated the skill and diligence of Thucydides in the description of the Plague at Athens." {50}
The account given by Procopius of this disease, does not differ materially from that given by subsequent eye-witnesses of similar pestilences. Its point of origin is clearly marked, and its mode of dispersion in all directions distinctly traced from "the neighbourhood of Pelusium, between the Serbonian bog and the eastern channel of the Nile." It commenced in the year 542. It raged in Constantinople in the following year, and it was in this city that our historian gathered the materials which are handed down to us. When, however, we anxiously look for any explanation as to the cause of the malady, we are told that it must have been a direct visitation from Heaven, in consequence of the eccentric characters exhibited in its wide-spreading influence, in not yielding to the scrutiny nor bending to the laws known to prevail, and to regulate the course of other diseases: neither country nor clime, age nor sex, the strong and healthy, nor the weakly and previously diseased, could be said to be free from its indiscriminate destruction.

But some phenomena preceding the outbreak of the pestilence are observed as coincidences by all authors. Gibbon thus writes: "I shall conclude this chapter with the comets, the earthquakes, and the plague which astonished or afflicted the age of Justinian." From the accounts given by this author, earthquakes for some years had been threatening and destroying many portions of the globe, that in the ruins of cities and in the chasms of the earth, great was the sacrifice of {51}
human life. Constantinople, which suffered so severely from the plague is said to have been shaken for forty days. These great disturbances of the globe have been always looked upon as indicating other and important influences of a secret or hidden nature; these impressions on the minds of the people are traceable throughout the histories of all epidemics, and have been sufficiently distinct among the people of our own time, preceding and during the period of infliction.

From this short notice of the Plague of 543, I pass to the ninth century, when Rhazes, the Arabian physician, endeavoured to enlighten the world on the subject of Small Pox.[19] In quoting his opinions, I am not to be understood as subscribing to them, but merely endeavouring to point out some peculiar and interesting observations.

First, then, Rhazes attributes the disease to a condition of the blood, which he thus describes, to shew how it happens that in infancy and childhood the disease is most prevalent, and that old age is least liable to the affection.[20] "The blood of infants and children may be compared to *must*, in {52} which the coction leading to perfect ripeness has not yet begun, nor the movement towards fermentation taken place; the blood of young men may be compared to must which has already fermented and made a hissing noise, and has thrown out abundant vapours and its superfluous parts, like wine which is now still and quiet, and arrived at its full strength, and as to the blood of old men, it may be compared to wine which has now lost its strength, and is beginning to grow vapid and sour."

"Now the Small Pox arises when the blood putrifies and ferments, so that the superfluous vapours are thrown out of it, and it is changed from the blood of infants which is like must, into the blood of young men which is like wine perfectly ripened: and the Small Pox itself may be compared to the fermentation and the hissing noise which take place at that time."

But the cause of the disease is simply alluded to by this author, as depending upon "occult dispositions in the air," and as he speaks here of Measles with the Small Pox he goes on to say —"which necessarily cause these diseases and predispose bodies to them." This notion of Rhazes that there is some peculiar condition of the blood which favours a process resembling fermentation is not without interest. The circumstance that individuals are not usually liable to a {53} second attack of the disease, no doubt directed the attention of this physician to compare the process of fermentation with disease of such a nature, seeing that when the whole of the saccharine matter was converted into spirit, the hissing noise, as he calls it, or the disengagement of carbonic acid gas would cease, and the capacity for fermentation be entirely gone. So that the occult conditions of the air, their power of inducing a disease, and multiplying the matter capable of engendering a similar affection, stood in the mind of Rhazes as analogous if not identical phenomena.

We pass now without further comment to the epidemics of the Middle Ages; and here the work of the philosophical Hecker leaves us little else to desire in the way of information, as far as it is obtainable from published records. From the manner in which he has grouped the facts which presented themselves to his mind in the course of a most laborious research, he has saved the student of this subject much toil in acquiring matter for reflection; he has here but to read and digest.

I know not how to select from this invaluable work the most striking passages, to strengthen and support my hypothesis, for not a page is destitute of facts corroborative of the doctrine that vital germs are the material agents of pestilential disorders. The opening paragraph to the Black Death is a most cogent illustration of the assertion; it is, as it were, the theme of the work. "That Omnipotence, which has called the world with all *its living creatures into one animated being*, {54} especially reveals himself in the desolation of great pestilences. The powers of creation come into violent collision; the sultry dryness of the atmosphere; the subterranean thunders; the mist of overflowing waters are the harbingers of destruction. Nature is not satisfied with the ordinary alternations of life and death, and the destroying angel waves over man and beast his flaming sword."

I must here apologise for large transcripts from Hecker's work, for neither could I command the amount of knowledge there displayed, nor use such appropriate language as the learned translator has employed.

It is not doubted that the Black Death was an Oriental plague, only of more than usual severity, and wider spread influence of the infectious nature of this disease, and the active properties of the matter producing it. Hecker says, "articles of this kind—bedding and clothes—removed from the access of air, not only retain the matter of contagion for an indefinite period, *but also increase its activity, and engender it like a living being*, frightful ill consequences followed for many years after the first fury of the pestilence was past."[21]

As extraordinary atmospheric and telluric phenomena preceded the Plague in the time of {55} Justinian, so do we find similar instances recorded as the precursor of a similar visitation 700 years later. I am concerned more with those circumstances which refer more especially to my subject, *viz.* the development of organic matter, and the peculiar odours of the atmosphere, the latter being evidence of some foreign and unusual production in our respiratory media. "On the island of Cyprus, before the earthquake, a pestiferous wind spread so poisonous an odour, that many being overpowered by it, fell down suddenly and expired in dreadful agonies. A thick stinking mist advanced from the east, and spread itself over Italy."

It is probable that the atmosphere contained foreign and sensibly perceptible admixtures to a {56} great extent, which, at least in the lower regions, could not be decomposed or rendered ineffective by separation. In 1348 an unexampled earthquake shook Greece, Italy, and the neighbouring countries. During this earthquake the wine in the casks became turbid, a proof that changes causing a decomposition of the atmosphere had taken place. "The insect tribe was wonderfully called into life, as if animated beings were destined to complete the destruction

which astral and telluric powers had began."

"The corruption of the atmosphere came from the east, but the disease itself came not upon the wings of the wind, but was only excited and increased by the atmosphere where it had previously existed."

"The most powerful of all the springs of the disease was contagion; for in the most distant countries, which had scarcely yet heard the echo of the first concussion, the people fell a sacrifice to organic poison, the untimely offspring of vital energies thrown into violent commotion."

"After the cessation of the Black Plague, a greater fecundity in women was every where remarkable, a grand phenomena, which from its occurrence after every destructive pestilence, proves to conviction the prevalence of a higher power in the direction of general organic life." {57}

In the article Contagion, of the Essay, Sweating Sickness: "Most fevers which are produced by general causes, propagate themselves for a time spontaneously." "The exhalations of the affected become the germs of a similar decomposition in those bodies which receive them, and produce in these a like attack upon the internal organs, *and thus a merely morbid phenomenon of life, shows that it possesses the fundamental property of all life, that of propagating itself in an appropriate soil. On this point there is no doubt, the phenomena which prove it have been observed from time immemorial, in an endless variety of circumstances, but always with a uniform manifestation of a fundamental law.*"

Mead, in his Essay on the Plague, makes many observations of great interest and worthy a physician of eminence; and where, in recent times, shall we look for any more definite information concerning the causes of pestilences? It is not a little singular that at the time this book was published, it was read with such avidity that it went through seven editions in one year. [22] From this circumstance we may gather that the public generally took a lively and proper interest in a subject that was not only of domestic, but national importance. Whether this interest was stimulated by the fact that the work was written expressly by order of the government, it is {58} now impossible to say, at any rate much credit is due to the Lords of the Regency for having placed so important a duty upon one so thoroughly and in every way so duly qualified for the task as Dr. Mead. It had been well if some of the advice given at that time, as means of protection against the Plague, had been applied and put in force during the late visitation of epidemic Cholera, for, however the minds of some may be convinced of the non-contagiousness of Cholera, there are many who hold a different opinion, and all will acknowledge, that if not strictly a contagious affection, it is clearly proved to be capable of being carried from place to place, or to use Dr. Copland's words, it is "a portable disease." But this is not the place to discuss the subject of contagion, allusion will be made to it hereafter. To return, Mead's expressions are singularly illustrative of the vital power possessed by the germs of disease; he says, "There are instances of the distemper's being stopt by the winter cold, and yet the seeds of it not destroyed, but only kept unactive, *till the warmth of the following spring has given them new life and force*. His confession as to the hidden cause of the disease, is worthy transcribing: "We are acquainted too little with the laws, by which the small parts of matter act upon each other, to be able precisely to determine the qualities requisite to change animal juices into such acrimonious humours, or to explain how all the distinguishing symptoms attending the disease are produced."[23] {59}

On the spread of the Plague is the following:—"The plague is a *real poison*, which being bred in the southern parts of the world, maintains itself there by circulating from infected persons to goods, that when the constitution of the air happens to favour infection, it rages with great violence." Contagious matter is lodged in goods of a loose and soft texture, which being packed up, and carried into other countries, let out, when opened, the imprisoned seeds of contagion, and produce the disease whenever the air is disposed to give them force, "otherwise they may be dispersed without any considerable ill effects." Gibbon thus speaks of the above quoted work: "I have read with pleasure Mead's short but elegant Treatise concerning Pestilential Disorders;" many also might read it at the present day with infinite advantage. Mead most satisfactorily combats the opinions of the French physicians who maintained the non-contagiousness of the Plague. Experience proves beyond doubt, that certain conditions of atmosphere, of which we are {60} ignorant, favour the growth and increase of pestilences as they do of all vegetation.

Dr. Bancroft was of opinion that specific contagions are each and severally creatures of Divine Wisdom, as distinctly and designedly exerted for their production, as it was to create the several species of animals and vegetables around us.

The indigenous fever of Ireland, which has several times shewn itself in an epidemic form, appears to have been as fatal, as the Plague in the South of Europe. Its devastations have generally been associated or preceded by famine and general distress. Dr. Harty, writing in 1820, says that thrice within the last eighty years has the same fever appeared in its epidemic character. In the year 1741 Ireland lost 80,000 of her inhabitants from this cause. It is a maculated typhus, and considered to be a special product of the Emerald Isle. It has been shewn that fever began to exceed its ordinary rate in those places first where famine and want of employment were most severely felt,[24] and that in such places and under such circumstances, it was most prevalent and fatal. The physicians generally believed it to have been spontaneously produced and not to have been imported. In the last Famine Fever of Ireland, Liverpool and several other places suffered severely from the importation of their Channel neighbours with the {61} disease in some instances, and the infection in others about their persons. Hitherto these have to

all appearance been the limits of the affection; we know not, however, how soon the time may come when the invisible bonds which have thus chained the disease to certain localities may be severed, and spreading itself like other pestilences in an aggravated form, attack this country as a last and crowning act of retributive justice. At present it has but cost us money and regrets, but if the history of pestilences is to be heeded, there are many tokens which seem to indicate that a few slight concurrent circumstances only are wanting, to bring the full force of this disease upon us; then will there be a sacrifice of life. Edinburgh and other towns of Scotland have had some visitations already, ourselves but slightly, but let our labouring population suffer to any large extent for want of work, and we shall inevitably be the sufferers from that fever which in consequence of general destitution is now always more or less prevalent in Ireland.

The Sweating Sickness prevailed in England alone at first, but at length sought foreign victims. The Cholera is an exotic disease, as well as the Plague, but they occasionally have visited our shores, and their seeds remain among us. The Small Pox is now even not known in some parts of the world, but when once it is established, who can predict the period of its first appearance in an epidemic form. The history of the disease informs us that in all the countries where it has been {62}
introduced, sooner or later an epidemic has seized the inhabitants.

A disease previously unknown in India appeared at Rangoon in the year 1824, which obtained the name of Scarlatina Rheumatica. Four years afterwards it attacked the Southern States of North America, and though the disease was so impartial as scarcely to spare a single individual of any town to which it extended its influence, it was not accompanied with that mortality which has usually been the characteristic of wide spread epidemics.

There is one peculiar feature of all epidemics which may be here mentioned as indicative of some definite, though at present unaccountable cause, operating in the sudden suppression of the disease after a certain period of duration. This distinctive character may almost be considered as a law in reference to these affections; if we take three distinct diseases, the Plague, the Irish Fever and the Cholera, we find the rule apply to all. Of the latter disease we have so recently been witnesses, that I need not quote authorities on this point concerning it. In Dr. Patrick Russell's work on the Plague at Aleppo I find the following remarkable passage. After alluding to the great increase of pestilential effluvia that there must be towards the close of an epidemic, compared with the amount at the onset of the disease, and expressing his astonishment that so {63}
many escape infection, he says: "The fact, however unaccountable, is unquestionably certain; the distemper seems to be extinguished by some cause or causes equally unknown, as those which concurred to render it more or less epidemical in its advance and at its height." He then mentions that in Europe the sudden cessation may be partly attributable to the measures adopted for preventing its extension; but "at Aleppo, where the disease is left to run its natural course, and few or no means of purification are employed, it pursues nearly the same progress in different years; it declines and revives in certain seasons, and at length, without the interference of human aid, ceases entirely."

The expressions of Dr. Harty on this subject, in connexion with the Irish Fever, would apply as well to all other epidemics: "It is a fact, that though every diversity of management was resorted to for effecting the suppression of the disease, yet, nevertheless, there was an almost simultaneous and apparently spontaneous decline of the epidemic in the various and most remote parts of Ireland. It is not an easy matter to offer a satisfactory explanation of this circumstance, *some general cause must* no doubt have influenced the subsidence of the disease, yet that cause could not be atmospheric, inasmuch as the decline, though it might be said to be simultaneous, was not sufficiently so to admit of that explanation."

SECTION III. {64}

THE DISPERSION OF PLANTS AND DISEASES.

The dispersion of Diseases and the dispersion of Plants, exhibit analogies which might be little expected, on a superficial view of the enquiry.

We are led to believe, that the earth as a whole, was not covered with vegetation in a day, the geological history of this planet is one of development, and though at first sight this expression of opinion may appear to savour of doubt in the Mosaic record, a more extended acquaintance with the subject, favours rather and confirms Scripture history.

As the peopling of the earth has been a gradual process with the animal creation, so has it been also with the vegetable kingdom. We see at the present day, that plants by various means of transit from place to place, multiply themselves on new soils and in new climes, the same with animals. By other means we observe, or can trace, the extinction from various localities and countries, of members of both the animal and vegetable kingdom.

We learn that originally this planet had a temperature much higher than at present, and that the variation of temperature between the equator and the poles, which we now witness, did not obtain in the earlier condition of the globe. We are given to understand, and not without considerable proof, if not demonstration, that the earth was a vast bog, in which rank vegetation {65}
grew, and in which the ichthyosauri and plesiosauri, must have floundered about as unwieldy and loathsome bodies. We can readily conceive a condition of atmosphere at this time to have been loaded with pestiferous vapours of an organized nature; it is entirely in accordance with all we know, that it should have been so. Allied forms of plants to those now in existence, are found in

the form of fossils, by which comparisons are made, but how the transition into the present Flora took place, or at what period, it is impossible to say. That these plants should have been entirely destroyed during the revolutions of the earth by earthquakes, and their consequences; the collection of waters into the vacuities formed, and their draining off from other places by elevations of the land, is not to be dwelt on without astonishment; then again the ultimate changes of temperature on the surface of the earth, may have been another element in the history of their extinction. But if we may be allowed to imagine that there were organic germs floating in the vapours of the atmosphere, these would hardly be subject to the same influences as those which depended solely on their fixation to the soil for subsistence. The atmosphere, their native element, being influenced by the commotions from below, would be agitated; vortiginous currents would be established, hurricanes would sweep over the stagnant pool and reeking morass, and the higher regions of the air might have thus given protection to these subtle germs, {66} while almost a total extinction of the elegant ferns, the stately palm, and the towering cane was in course of procedure. Then when the strife of the earth and elements had subsided, these would descend with the gentle breezes, and again find in various spots a local habitation—

> "Where blue mists, through the unmoving atmosphere,
> Scatter the seeds of pestilence *and feed unnatural vegetation*."

In the new era, when the earth took its present physiognomy, who shall say whether much of the pestiferous matter may not have been enclosed and condensed in the bowels of the earth, and when it is remembered, that earthquakes and convulsions of nature,[25] have invariably preceded the outbreak of any great pestilences, that stinking mists, coming from some unknown regions, {67} and unusual vegetations have made their appearance in concert at these times, what I ask is more natural than to imagine, that they have been let loose during the general convulsion? It may be asked, what is to be said about that revolution of the earth, when the great Deluge spread over the whole face of the globe? It can only be replied, that this is a part of the scheme of cosmogony into which we are not called upon to enter. There are yet strenuous supporters of the partial as well as total submersion of this planet, but whether it be true that the vast torrents which appear to have swept the surface uniformly in a southern direction, were of a date coeval with the deluge, and constituted an essential portion of the phenomena, of which one was, that "the fountains of the great deep were broken up," or whether they were anterior to this catastrophe, will not at all interfere with the conjecture of a very early formation and propagation of the germs of pestilential diseases, for the commotions of a deluge were less likely to interfere with the vapours of the atmosphere, than extensive volcanic and electric disturbances. Moreover, it is rather in favour of this theory, that the regions where the temperature and exhalations most {68} nearly resemble those of the former condition of the earth, are those in which pestilential disorders most frequently arise, and where their virulence has always been most strongly marked.

After the various commotions which left the globe, with its present physiognomy of mountains, plains, valleys, rivers, lakes, and oceans; a new Flora and Fauna appeared to adorn and animate the scene of man's existence. Plants and animals were created apparently in adaptation to the numerous climes, which the seasons in the various latitudes or the elevations of the soil, were prepared to render fruitful and useful each in its own sphere. Besides this, the plants of the same latitude, in some instances, differ materially from each other; in this case it seems that the soil has much to do with this peculiarity, for it is certain that the soil and the contiguous atmosphere, have a close and intimate relation; the drought of the desert depends upon the sand, as humid atmosphere is connected with the morass. To illustrate the tendency which vegetation shews in appropriating one locality more than another, I may quote the following: "Some of the volcanic masses of the Æolian or Lipari Islands, that have existed beyond the reach of history, are still without a blade of verdure; while others in various parts, of little more than two hundred years date, bear spontaneous vegetation, and the same is seen on two lavas of Etna near each other, for the one of 1536 is still black and arid, while that of 1636, is covered with oaks, fruit trees, and {69} vines."

In comparing the diffusion of plants, and the diffusion of diseases, the different modes by which this generally has been effected may be considered under heads, that the comparison may be more readily traced.

First, seeds are diffused by the atmosphere, either by the prevalence of certain currents, which are produced by known laws, in which case, no difficulty occurs in the explanations; or in a more imperceptible manner, as by those more uncertain atmospheric currents of a partial nature, which, though they seem to have laws governing them, are not yet understood.

Second, seeds are transported by water across oceans, &c. when they can be floated on any material by which they are preserved, as by wrecks and masses of wood, which have been washed down the rivers.

Third, they are conveyed by man to all parts of the globe.

Fourth, a period of latency is observed to apply to them, that is, they require certain essential conditions before germination occurs; so that even in some localities, a plant may not have been known to exist in a particular neighbourhood, but by a train of circumstances, it may make its appearance, and again be a centre of development.

1st. I shall not here wander into the speculation, whether plants had originally one birth-place, as {70}

a centre from which they spread by various agencies, as supposed by Linnæus, nor into any enquiry beyond those facts, which may fairly come within our own comprehension, and within our own means of demonstration.

Many seeds are provided with means adapting them for floating in the atmosphere, these are by pappi, or winglets and hairs, but it cannot be doubted that the agency of atmospheric currents, is productive of considerable effects in the dispersion of lighter seeds, such as those of mosses, fungi, and lichens—lichens have been discovered in Brittany, which are peculiar to Jamaica, and Monsieur De Candolle concludes, that their seeds had been carried thence by the south-westerly winds, which prevail during a great part of the year on this portion of the French coast.

But Humboldt's testimony on the subject of winds is most satisfactory, for he says, "Small singing birds, and even butterflies, are found at sea, at great distances from the coast (as I have several times had opportunities of observing in the Pacific), being carried there by the force of the wind, when storms come off the land." It is generally believed, from abundance of proofs, that the trade winds, and other continuous currents, are means by which plants are conveyed from one country to another.[26]

As to the partial currents, Humboldt further says, "The heated crust of the earth occasions an {71}
ascending vertical current of air by which light bodies are borne upwards. M. Boussingault, and Don Mariano De Rivero, in ascending the summit of the Silla, one of the gneiss mountains of Caraccas, saw in the middle of the day, about noon, whitish shining bodies rise from the valley to the summit of the mountain, 5755 feet high, and then sink down towards the neighbouring sea coast. These movements continued uninterruptedly for the space of an hour. The whitish shining bodies proved to be small agglomerations of straws, or blades of grass, which were recognized by Professor Kunth, for a species of vilfa, a genus, which together with agrostis, is very abundant in the provinces of Caraccas and Cumana."

On the plague of locusts we read, that "the Lord brought an east wind upon the land, all that day and all that night, and when it was morning the east wind brought the locusts."

On the Black Death we read, "There were many locusts which had been blown into the sea by a hurricane, and a dense and awful fog was seen in the heavens, rising in the east, and descending upon Italy."

Of the Plague of 542, Gibbon says, "The winds might diffuse that subtle venom, but unless the atmosphere be previously disposed for its reception, the plague would soon expire in the cold or temperate regions of the north. The disease alternately languished and revived, but it was not till {72}
a calamitous period of fifty-two years, that mankind recovered their health, or the air resumed its pure and salubrious quality."

In the history of the Sweating Sickness, of which there were five distinct visitations, we find ample allusions to the atmosphere, and the mode in which the disease was conveyed by this medium.

I quote again from Hecker: "It seemed that *the banks of the Severn* were the *focus of the malady*, and that from hence, a true impestation of the atmosphere, was diffused in every direction. Whithersoever the winds wafted the stinking mists, the inhabitants became infested with the sweating sickness. *These poisonous clouds of mists were observed moving from place to place*, with the disease in their train, affecting one town after another, and morning and evening spreading their nauseating insufferable stench. At greater distances, these clouds being dispersed by the wind, became gradually attenuated yet their dispersion set no bounds to the pestilence, and it was as if they had imparted to the lower strata of the atmosphere, *a kind of ferment which went on engendering itself even without the presence of the thick misty vapour*, and being received into men's lungs, produced the frightful disease everywhere."[27]

Mr. K. B. Martin, harbour-master of Ramsgate, in a communication to Lord Carlisle on the {73}
Cholera of last autumn, says, "At midnight of the 31st August (1849), the Samson (steam-tug) proceeded to the Goodwin Sands, where the crew were employed under the Trinity agent, assisting in work carried on there by that corporation. While there, at 3 A.M. 1st September, *a hot humid haze, with a bog-like smell*, passed over them; and the greater number of the men there employed instantly felt a nausea. They were in two parties. One man at work on the sand was obliged to be carried to the boat; and before they reached the steam vessel at anchor, the cramps and spasm had supervened upon the vomitings; but here they found two of the party on board similarly affected. Here then is a very marked case without any known predisposing local cause. Doubtless it was atmospheric, and in the hot blast of pestilence which passed over them."

Many more instances might be quoted, to shew that the germs of disease, as well as of plants, are borne on the wings of the wind from place to place in one country, and from one country to {74}
another, the distance being no obstacle, however great that may be.[28] "Dust and sands," says Sharon Turner, "heavier than many seeds, are borne by the winds and clouds for several hundred miles across the atmosphere, falling on the earth and seas as they pass along." "The clouds not only bring us occasionally meteoric stones, hail, and *epidemics*, but also vegetable seeds."[29]

2nd. The transportation of seeds of plants by water requires very little notice; every one is familiar with the mode in which coral islands, which gradually rise out of the sea, become covered with vegetation. "If new lands are formed, the organic forces are ever ready to cover the naked rock with life.—Lichens form the first covering of the barren rocks, where afterwards lofty {75}

forest trees wave their airy summits. The successive growth of mosses, grasses, herbaceous plants and shrubs or bushes, occupies the intervening period of long but undetermined duration."

The following may be cited as an instance of the transportation of disease by water. "Cyprus lost almost all its inhabitants, and ships without crews were often seen in the Mediterranean, or afterwards in the North Sea, driving about, *and spreading the plague wherever they went on shore*."[30]

It requires no argument to enforce the conviction that cottons, woollens, furs, skins, &c. will retain the matter of infection for almost an indefinite period; instances of the kind have been already given; it is therefore easy to understand that portions of wrecks and ship's goods would be a frequent though unsuspected source of infection. Dr. Halley mentions a case, in which a bale of cotton was put on shore at Bermuda by stealth; it lay above a month without prejudice, where it was hid, but when opened and distributed among the inhabitants, it produced such a contagion that the living scarce sufficed to bury the dead. Dr. Walker found seeds dropt accidentally into the sea in the West Indies cast ashore on the Hebrides. He says, "the sea and rivers waft more seed than sails." The waters of many rivers induce diarrhœa and dysentery.[31] Well water also in many places has a similar effect, especially if any surface drainage happens to find its way into the well. {76}

3rd. The part performed by man himself in the communication of disease to his fellow creatures, is perhaps the most fruitful source of the extensive spread of epidemic and contagious diseases.

In the time of Moses, restrictions were laid on those who had the plague of the leprosy to avoid contagion; the dictum for one so affected was, "he shall dwell alone; without the camp shall his habitation be."[32] All the ancient authors believed in the infectious nature of pestilential fevers, and some other diseases; but, according. to Mr. Adams, they held that no specific virus was the cause, and merely a contamination of the surrounding air by effluvia from the sick. Thucydides, Hippocrates, Procopius, Galen, Plutarch, all recognized the property of communicability from one individual to another of the plague; and Hecker, on the epidemics of the middle ages, abounds with instances in support of contagion. As regards small-pox and measles, Rhazes observes particularly the connection that exists between the condition of the air and the severity or mildness of these diseases, remarking that small-pox seldom happens to old men, except in pestilential, putrid, and malignant constitutions of the air in which this disease is usually prevalent. {77}

The history of the introduction of Scarlet Fever, Hooping Cough, Lues, and other diseases into the various countries of the globe, is sufficiently convincing that men carry about with them the seeds of disease; that while these attach themselves to the persons and clothing of those who introduce them into new climes, and flourish independently of cultivation, yet the exotics which they foster with so much care, often disappoint their most sanguine expectations; and these "languishing in our hothouses can give but a very faint idea of the majestic vegetation of the tropical zone." Art in this procedure fails to accomplish here, what nature but too sadly, under some circumstances, effects most readily. The germs of some diseases though of an exotic character, under congenial influences of various kinds, appear to flourish with native vigour: is it not so, also, with some forms of vegetation? The aloe, a native of Mexico, which lives, but does not thrive well, or reproduce under ordinary circumstances in this country, will occasionally send forth a most luxuriant blossom;[33] so rare is this, that some say it occurs every 50 or 100 years, but no law seems to be established on this point, any more than the statement that we may expect pestilential diseases at certain intervals. But that there are intervals of *uncertain* duration when the aloe will blossom, when the grapes will ripen, and a general productiveness of exotics will occur, is as certain as that seasons will occur when contagion will be rife, and a most unusual multiplication of disease prevail. This is not an imaginary or speculative notion,—all observers of seasons and diseases within the last twenty years, may fully verify the statement. {78}

In 1846, a large vine, the black Hambro-grape, ripened its fruit out of doors, and was as fine as any green-house production; but during nine years that the vine has been under my inspection, this was the only time I have witnessed such a result. {79}

We are apt to attribute an abundant or scarce fruit season to temperature alone, but this is an error—for we have before remarked, that though certain lands may be in the same degree of latitude, the plants which thrive well on one land, will not do so on the other: in fine, that where reason and analogy would lead one to expect a particular form of vegetation, a totally different Flora is presented to the view. These facts are indeed suggestive of new and important deductions. Is it yet explained why the town of Birmingham should be free from Cholera? There is a large manufacturing population, a great number of poor, the usual overcrowding of individuals in small chambers, a considerable amount of destitution and depravity; irregular habits of living, and unwholesome diet, and doubtless many parts of the town, which on investigation would have yielded all the elements usually considered necessary for the localization of the disease: but no—here was some repelling cause, some opposing agent to the generation and propagation of the pestilential seeds. There are no known laws by which inorganic matter could be supposed to observe such a selection, or such an antagonism. Electricity, magnetism, ozone, gases, exhibit no such elective properties that here they will destroy, and there they will spare; that they can almost depopulate small villages, and scarcely find a victim in Birmingham and Bath. But if we suppose a living, and multiplying matter as the cause of disease, many local causes may conspire to arrest the development of the germs, or perhaps, even utterly destroy them. {80}

4th. As to the time of latency, facts crowd upon us indefinitely, as elements of comparison between vegetation generally, and disease in its early stages and history. The seeds of plants are extraordinarily tenacious of life. What a mysterious arrangement of the ultimate particles of matter must there be, by which the vital force remains apparently inactive for many years, and yet when the conditions arise favourable to its manifestation, as it were by an extraordinary fiat, life appears.

Previous to the year 1715, no broom grew in the King's Park, at Stirling; but in that year a camp was formed there, and the surface of the ground consequently was broken in many places. Wherever it was broken, broom sprang up. The plant was subsequently destroyed; but in 1745 a similar growth appeared after the ground had been again broken for a like purpose. Some time afterwards the park was ploughed up, and the broom became generally spread over it. "In several places in the neighbourhood of Edinburgh," says Professor Graham, "the breaking of the surface produces an abundant crop of Fumaria parviflora, although the same plant had never {81} before been observed in the neighbourhood. It is impossible to say the lapse of time since these were buried, before they were again excited to the performance of all their vital functions." Dr. Graham also gives another proof of the vital force existing in seeds. "To the westward of Stirling there is a large peat bog, a great part of which has been flooded away by raising water from the River Teith, and discharging it into the Forth,—the under soil of clay being then cultivated. The clergyman of the parish standing by while the workmen were forming a ditch in this clay, which had been covered with fourteen feet of peat earth, saw some seeds in the clay which was thrown out of the ditch; he took some of them up and sowed them: they germinated and produced a crop of Chrysanthemum septum. What a period of years must have elapsed while the seeds were getting their covering of clay, and while this clay became buried under fourteen feet of peat earth!"[34]

What limit can there be to the dispersion of seeds when their vital properties may remain so long {82} unimpaired? The seeds of which we have been speaking were, no doubt many of them, washed away with the waters of the Teith, and carried by the stream into the Forth; and who shall then mark their destination; for we have seen that by such means the most distant lands are supplied with vegetation; for whence come the plants which cover the Coral Islands, unless by the air and the water, and that both contribute, has been incontestably proved. Dr. Lindley states that melon seeds have been known to grow when forty-one years old; maize thirty years, rye forty years, the sensitive plant sixty years, kidney-beans a hundred years. But seeds in general have an indefinite period, apparently, at which they can retain their power of germination; for many of the seeds which had been kept in the herbarium of Tournefort for more than a century, were found to have preserved their fertility.

It has now to be shewn that the germs of disease also retain their vital powers in a state of dormancy during a lengthened period.

Mead has very judiciously observed, "to breed a distemper, and to give force to it when bred, are {83} two different things." He further remarks, that the seeds of the Plague may confine themselves to a house or two during a hard frosty winter, and be preserved, and again put forth their malignant quality as soon as the warmth of the spring gives them force. It is certainly very remarkable that the Plague of London, which commenced at the latter end of the year 1664, should "lie asleep," as Mead says, from Christmas to the middle of February, and then break out in the same parish.

It has been also known that an infected bed laid by for seven years had done infinite mischief on being again brought into use. Indeed, it is quite uncertain for how long a period woollen, fur, linen, cotton, and other articles may retain infectious matter in a dormant state. It has been supposed by some that in closely packed bed and body clothes a multiplication of the germs may and does take place, nor do I see any reason why this should not be the case, for these articles contain within their structure the effluvia of the animal body, and they may possibly there find sufficient nutriment for their development. Nees von Esenbeck believed that some of the minute Cryptogamia were re-produced in the air, we are not therefore exceeding philosophical conjecture when we imagine a basis and substratum, though an unusual one, for the germs of vegetation. Exclusion from air and light, however, as would be the case in packed-up clothes, {84} would *a priori* give a better colour to the conjecture, as these are the usual conditions necessary for the growth of seeds.

Small Pox and Cow Pox matter, which are now proved to be the same virus, the former modified by having been through a process of growth and maturation in the cow, are both remarkable for exhibiting their active properties after having lain dormant for a considerable time. And each, though so closely allied, retaining its specific properties.

This peculiarity in the history of Small Pox virus suggests a comparison with some phenomena of vegetation, *viz.* that of grafting or budding. The lower Cryptogamia in their fructifications resemble rather multiplication by buds than by seeds. M. Moyen's idea is that every spore or little globule, independently of its neighbouring one, lives, absorbs, assimilates, grows, and re-produces on its own account; this is certainly the characteristic of the Torula and the Uredo, and doubtless is so of many other of the Cryptogamia, the Protococcus nivalis is another instance. Other modes of cultivation produce also great varieties of results of an unexpected kind.

Would any one, says Dr. Walker, imagine that cabbage, cauliflower, savoy, kale, brocoli, and turnip-rooted cabbage, were the same species? yet nothing is more certain than that they are only varieties produced by the cultivation of the Brassica oleracea, a plant which grows wild on {85}

the sea-shores of Europe.

These varieties in vegetables have now become permanent, and though it is supposed that each is liable to return to its original condition, I am not yet certain that such is the tendency. A deterioration is not unlikely to ensue in the course of time, because the propagation by seeds must necessarily very much approach the system of intermarriage, on which Mr. Walker has so ably written and clearly shewn that as a result we may invariably expect a deterioration of the species. Dr. Darwin has also poetically described what his experience taught him.

> "So grafted trees with shadowy summits rise,
> Spread their fair blossoms and perfume the skies,
> *Till canker taints the vegetable blood*,
> Mines round the bark and feeds upon the wood;
> So years successive from perennial roots,
> The wire or bulb with lessened vigour shoots,
> Till curled leaves or barren flowers betray
> A waning lineage verging to decay;
> Or till amended by connubial powers,
> Rise seedling progenies from sexual flowers."

The minute nature of the germs of disease preclude all possibility of their being submitted, as far as we know at present, to the inspection of the physiologist, but we may infer many facts from results. In the same way, though with humbler ideas, as Cuvier could build up an animal from a {86}
single bone, can we by a combination of facts infer the existence of living beings and conjecture their forms. "The re-production or generation of living organized bodies is the great criterion or characteristic which distinguishes animation from mechanism." We find the virus of Small Pox, according to Mr. Ceely's experiments, developing itself as a constitutional disease upon the cow, and becoming modified into a form known as the Cow Pox; this resembles the process of cultivation by which a species is converted into a variety, this variety remains for a certain time persistent; the time is not yet known, but it is known that by degrees, as stated above, a deterioration occurs, and fertility becomes impaired, "a waning lineage verging to decay," and this has been observed as a feature in the result of vaccination. I believe Dr. Gregory was one of the first to notice this fact, and deemed it necessary to obtain fresh lymph from the cow; this has been done, and it is not improbable, if the analogy we have drawn be correct, that the slowly spreading scepticism regarding vaccination may be arrested in its progress. If we can explain the deterioration of cow pox virus on this principle we have a hold at once upon the public, and can assure them that the efficacy of the proceeding is as certain as in the time of Jenner. The people, I contend, have a right to demand of us the reason why vaccination is not so efficacious as formerly, and I affirm as unhesitatingly that we are bound to give the subject our most earnest {87}
attention.[35]

Now concerning the re-production of Cow Pox matter, and assuming it to resemble that of the lower Cryptogamia, we can easily understand how degeneration in a course of years should ensue, for we find that though the Small Pox is a constitutional disease, that produced by vaccine lymph is a local affection, so that it bears the relation that grafting does to vegetation, and it is not improbable that such a modification takes place in the germs by passing through or becoming generated in the blood of the cow, that they entirely lose their original and characteristic form of reproduction: the seeds of the disease were originally capable of vegetating, if I may be allowed to use the term, by diffusion through the atmosphere; they now, however, have lost that property, and require to be grafted to exhibit any manifestation of vitality.

How often will the seeds of a cultivated fruit grow? If you bud it upon another plant, you obtain a being exactly like the parent, but this, as we have seen, deteriorates in a course of years, we have also seen that the virus deteriorates; but not to stretch this point to an unseemly length, I cannot avoid expressing my conviction, that these are elements of comparison, possessing an interest and a practical utility of no small value.

I have before said, that the reproduction in the Cryptogamia, rather resembles budding than {88}
seeding. If we observe the Torula, or take the process of all formation, generally it will be found to accord more exactly with the budding than the seeding process, and this peculiarity is not confined to vegetation, it is also a marked feature in the reproduction of infusoria, sponges, polypes, &c.

> "New buds surround the microscopic plant."

The reproduction of plants and animals appears to be of two kinds, solitary and sexual; the former occurs in the formation of the buds of trees, and the bulbs of tulips.

The microscopic productions of spontaneous vitality propagate by solitary generation only.

We have but reached the threshold of this vast and interesting subject, the experiments which suggest themselves to the mind while reflecting upon it, would alone occupy a whole life of leisure, and I can but feel how forcibly Mr. Sewell's words apply to us: "The grand field of investigation lies immediately before us, we are trampling every hour upon things which to the ignorant seem nothing but dirt, but to the curious are precious as gold."

It is difficult, perhaps, to bring many instances, in which the germs of disease have lain dormant for a lengthened period, because many may take exception to them, from the fact, that sporadic

cases of most epidemic and infectious diseases, are rarely absent from any country in which those diseases have become indigenous, and these cases may be said to be the foci whence originates the epidemic constitution of the air; this, however, would not invalidate the supposition, because one of two inferences must be drawn, either that the germs of disease always exist in a dormant state, requiring circumstances and conditions only for their development, or that the germs are imported from some distant locality, where the disease has occurred, and finding a nidus there, grow and multiply.[36] Whichever notion we take, however, matters very little to the fact of the dormancy of the germs, for in both, a certain period elapses between their transmission and their propagation. It may fairly be presumed, that sometimes one method may apply and sometimes the other, perhaps both during general epidemic conditions of the atmosphere. {89} {90}

The Oidium vitis attacked the vines partially last year, and I believe generally spared other forms of vegetation; but this year in my vicinity, cucumbers, melons, and vegetable marrows, are all suffering more or less under the disease.[37] How shall we say, whether are the seeds of last year the cause of the general diffusion at the present time, or were there a sufficient number of old and dormant seeds, universally diffused, and only waiting opportunities for multiplying themselves? We are here on the horns of a dilemma; and spontaneous generation, from which one naturally shrinks, can alone extricate us, if we do not admit diffusion and dormancy. I think I may, without undue assumption, affirm that a period of latency of indefinite duration, applies as cogently to the germs of disease as to those of plants.

There is yet one other point in connection with this subject, and that is the apparent extinction of some diseases, at any rate their non-appearance in certain localities, which had been at one time congenial to them, and in which they flourished. We have seen, in illustrating the dormancy of seeds, that the broom must have been a common plant at some considerable period back, in the King's Park at Stirling, or on that site. {91}

Then again, the appearance of Fumaria parviflora in the vicinity of Edinburgh, in several places where the ground is broken, is sufficiently convincing that this plant must once have been a common form of vegetation there; and as it had never before been observed in the neighbourhood, there must have been a combination of peculiar circumstances capable of rendering germination impossible, otherwise a continued multiplication, as in other forms of vegetation, would have followed of necessity.

But besides these instances, how many are passing under our own eyes of the disappearance of plants under the influence of cultivation, and the generation of the noxious fumes arising from different and innumerable manufactories. In the vicinity of large cities and manufacturing towns, how rarely do we see healthy vegetation; shrubs and animals drag on a sickly and almost unprolific existence, and their term of natural life is much shortened.

And if we compare diseases with this peculiar feature of vegetation, how very close do we find the analogies. The Sweating Sickness which appeared in the latter part of the fifteenth century, and at certain intervals multiplied and extended itself at first only in this country, but ultimately more or less over the continent of Europe, has never since the year 1551 shewn any symptom of productiveness, indeed for all we know the disease may be extinct; on the other hand, it is impossible to say whether or not circumstances may arise, under which it may commence again, to put forth its energies and again desolate the land.[38] {92}

Since 1665, the Bubo-plague has not found a congenial soil in this country, or if the seeds be here, which is more than probable, the necessary conditions to excite them to activity do not exist.

It cannot be imagined that with all the merchandize which comes into this country from the Mediterranean, but that an abundance of the germs of the disease are annually brought into our ports, and disseminated throughout the land. The law by which we have seen that they possess a power of vitality and reproduction, holds now as it did in former times;—the properties of matter never alter, but the conditions under which they exist may be so modified, as to influence their properties, and the usual course of their operations. It is therefore to an alteration or modification of conditions that we are to look for the exemption, during the last two centuries, from an invasion of the Plague. To say what those conditions may be in their totality is difficult, perhaps impossible. We may generalize on the subject, and imagine the reason discovered, but all those causes which were said to have conspired to favour the spread and contamination with Plague, were as distinctly specified and attributed, as the cause of our late infliction with Epidemic Cholera. Why then did we have the Cholera and not the Plague? To what particular element was it—in the mode of living, of destitution, of filth and want of drainage—can it be ascribed that we suffer under one disease, and not under the other? {93}

We have made some few observations and comparisons on the mode of dispersion of plants and diseases,—but there is yet one more point which invites notice. Not only do seasons vary in their effects on vegetation in a remarkable and unexplained manner, but there are many localities to which some special form of vegetation attaches, and which appear to have a power of exclusion of other forms; and as yet I have not been able to trace the connexion, nor can I discover it in the writings of botanists and travellers, who would be most likely to have sought an explanation of so interesting and curious a fact. Dr. Prichard has on this subject some very apposite illustrations. "Still further southward, the austral temperated zone completely changes the physiognomy of vegetation, and the Isle of Norfolk has, in common with New Holland, the Auracania found also in {94}

the harbour of Balade, and with New Zealand, the Phormium tenax. It is however remarkable, that this vast island, composed of two lands, separated by a channel, though so near New Holland, and lying under the same latitude, differs from it so completely, that they display no resemblance in their vegetation. Yet New Zealand, so rich in genera peculiar to its soil, and little known, has some Indian plants: such as Pepper, the Olea, and a reniform Fern, which is said to exist in the Isle of Maurice."

I must quote one more passage from Dr. Prichard's excellent work. "We have one instance of an island at no great distance from a continent, having a peculiar vegetation. Mr. R. Brown has remarked, that there is not even a single indigenous species characterising the vegetation of St. Helena, that has been found either on the banks of the Congo, or on any other part of the Western coast of Africa. Does the diversity of marine and atmospheric currents more completely separate this island from the continent, than its situation would imply; or are the nature of soil and other local circumstances, the cause of so marked a diversity? The last supposition seems the most probable; because not only the species of plants, but likewise the genera in St. Helena, are different from those of the African coast." {95}

We are not without instances of diseases, observing this peculiarity which attaches to plants; but their specific characters have hardly been sufficiently considered in reference to climate and situation, together with diet and local influences, to afford us accurate data for comparison. It has, however, been remarked, in every country where Epidemics have prevailed, that some districts or tracts of country, though supposed to possess all the qualities favourable to the development of the diseases, have nevertheless been entirely or nearly free from them. The following passage on the course of the Cholera gives an example of this peculiarity. "Whenever the malady deviated, so to speak, from its normal direction, and passed towards the west, it seemed incapable of propagating itself; and *died away spontaneously, even in places which appeared to be well fitted for its reception*.—The rich fertile and densely peopled countries to the right of the Dneiper, enjoyed an equal freedom from attack, which can only be explained by the fact that they were situated *beyond the line of the disease*." With this I close the subject of the diffusion of plants and diseases, though it would require a volume of itself, to record all that has been noticed. I have endeavoured to select such instances as shall mark distinctly the features which point to comparison without overloading the enquiry.

SECTION IV. {96}

THE RELATION BETWEEN EPIDEMIC AND ENDEMIC DISEASES.

Epidemic diseases, which multiply their germs in any climate, and under apparently the most varying conditions of temperature and hygrometric and electrical states of atmosphere, offer many points of contrast with Endemic affections, and many of relationship. The latter are traceable to a certain extent, to geological and geographical positions of the localities where they are observed to prevail, in combination with atmospheric vicissitudes and peculiarities, as well as to extent of cultivation of the soil: it has been remarked that the sickly island (as it is called) of St. Lucia has certain salubrious parts, but these are where sulphur abounds; this geological peculiarity has been deemed sufficient to account for the absence of endemic affections in these parts, and with much force of reason; for in the neighbourhoods where sulphur or sulphurous acid, a compound of sulphur, is an element prevalent in the soil or atmosphere, vegetation and the ague disappear together.

Now ague, and other endemic fevers, doubtless originate from some allied, if not identical cause; for the localities in which they appear have so many features in common, that we are constrained {97} to acknowledge that endemic fevers have some relations and analogies, though not yet unravelled.

Geographical situation, together with certain vegetation, particularly of grounds which grow rice, is one remarkable for the production of endemic affections. But the soil which generates or gives force to the contaminating matter, is not alone the part where human beings feel its influence most severely. A low marshy ground, prolific of malaria, may be comparatively free; while some neighbouring elevated land, to which prevailing currents of air waft the volatile elements of disease, may be desolated by their virulent and concentrated action. "Malaria may be conveyed a considerable distance from its source, *and be condensed* in the exhaled vapour, when attracted by hills or acclivities in the vicinity, and when there are no high trees or woods to confine it, or to intercept it in its passage."

The inhabitants of the city of Abydos were at one time subject to disease, arising from malaria, generated in some neighbouring marshes; by draining these marshes, which suspended the growth of rank vegetation, the city became healthy.

Rome is in like manner even now subject to fevers, having a similar origin. Sir James Clark says, "Among the more prevalent diseases of Rome, malaria fevers are the most remarkable, and claim our first notice." He considers the fevers to be of exactly the same nature as those of Lincolnshire and Essex in this country, of Holland, and certain districts over the greater part of the globe. To {98} the climate, the season, or the concentration of the cause of these fevers, he attributes their varieties. It is the same disease, he says, whether from the swamps of Walcheren, or the pestilential shores of Africa.

From July to October the inhabitants of Rome are most subject to these affections.

Sir James Clark further says: "It may be stated as a general rule, that houses in confined shaded situations, with damp courts or gardens, or standing water close to them, are unhealthy in every climate and season; but especially in a country subject to intermittent fevers, and during summer and autumn. The exemption of the central parts of a large town from these fevers, is explained by the dryness of the atmosphere, and by the comparative equality of temperature which prevails there."

In this respect there is a marked difference between an epidemic and an endemic affection; for when an epidemic disease attacks a city or town we do not discover that the central parts are more exempt than others; indeed, it is rather the contrary; for the most crowded parts of towns and cities are those, if not exactly in the centre, which would be comprised in a space nearer to the centre than the circumference; and it has been in those parts generally where the epidemic influences seem to have exercised the most potent sway. One would more naturally suppose, that a city surrounded by paludal miasm, and not itself being capable of generating the poison, should {99}
be more affected at the circumference, from the simple fact that the paludal germs, which rise in the air, are suspended in the fogs and dews of the atmosphere. These, unless widely dispersed by the winds, would remain within a comparatively confined space; and those situations nearest to them would be most subject to their influence. Besides, it has been shewn, that a small wood or hill, or even a wall, has been sufficient to cut off or obstruct the paludal miasm.

Without enumerating all the known endemic diseases, two or three may be alluded to for our present purpose; viz. that of shewing that endemic and epidemic diseases have a similar origin. [39]

It is well known that under certain favouring conditions an endemic may become a malignant and pestilential disease; that Yellow Fever, which is always endemic in the west, Cholera in the east, and the Plague in the south of Europe and north of Africa, every few years takes on an epidemic form, and desolates considerable tracts of country.[39]

The Pestilence which raged in the summer and autumn of 1804 in Spain, commenced at Malaga, and remained for a considerable time confined to its boundaries, in consequence of the measures {100}
of precaution that were used, in preventing all communication between the inhabitants of the infected city and those living in the surrounding country. It was only in consequence of persons escaping through the cordon, and passing into the interior of the country, that the disease spread, and extended its ravages to distant places.

It appears to be quite clear, that this disease may properly be considered in the first instance of endemic origin; but the tendencies, atmospheric and otherwise, were such as to favour its multiplication in other districts than that in which it first came into active existence. From this we may infer, that the seeds of the disease were dormant, and only became roused into vital activity by fortuitous circumstances. Dr. Rush states, that the endemic disorders of Pennsylvania were converted, by clearing the soil, to bilious and malignant remittents, and to destructive epidemics. Dr. Copland says, it has been observed, especially in warm climates, and in hot seasons in temperate countries, that when the air has been long undisturbed by high winds and thunder-storms, and at the same time hot and moist, endemic diseases have assumed a very severe and even epidemic character.

Dr. Robertson also confirms this view. "Endemic diseases, in cases of neglect and preposterous management, are found to become more malignant even in the most temperate climates; and to generate a matter in their course, capable of producing a particular disease in any {101}
circumstances. *Indeed the origin of every* contagious fever unattended with eruptions, with the exception of Plague, must commence in this way." Why Dr. Robertson should except eruptive Fevers and Plague I cannot understand, for they must have had a commencement; and their many points of similarity indicate, if not an identical, an analogous source to other endemic fevers.

It will doubtless be generally acknowledged that endemic and epidemic diseases depend upon some unknown agents, having their source in malarious districts, and being capable of assuming either a contagious or non-contagious character, according to circumstances.

If, therefore, we find that under any conditions an endemic affection becomes capable of being propagated by contagion, the same law will hold with regard to it as to the Plague; that the power of reproduction in this matter is evidence of life, according to the doctrine laid down in the earlier part of this work. But whether or not infection be admitted, a matter generated in a malarious district, if confined in its effects to that district alone, would not necessarily imply an inorganic nature of the poison; for it is difficult to understand how inorganic poison, prevailing generally over a certain tract of country, could select particular individuals for its victims. If chloroform, chlorine, carbonic acid, sulphuretted hydrogen, or even spores of poisonous fungi, (as supposed by Mitchell, which, as he regards their effects, would act in a similar manner to {102}
inorganic compounds) were the agents, all persons would suffer more or less, and the majority be similarly affected. We do not find that uniformity of symptoms, which attend upon the exhibition of poisons in the ordinary acceptation of the term, poisoning. This subject shall be more particularly considered, when treating of the influence of organic germs on animals and plants.

The history of the Eclair steamer is particularly interesting, as shewing the extraordinary tenacity with which the germs of disease attach themselves to vessels, which we may call floating houses.

The crew of the Eclair contracted Yellow Fever on the coast of Africa, and a number of them died. The remainder, sick and well, landed at Bona Vista, one of the Cape de Verde Islands, and the vessel underwent a process of washing, whitewashing, and fumigating. Nevertheless, on the return of the ship's company, the disease broke out again with equal intensity, and the vessel was ordered home. Sixty-five out of 146 officers and men, who composed the crew, died of the disease before reaching Portsmouth, and twenty-three were sick at the time of arrival.

Eight days after the Eclair left Bona Vista, a Portuguese soldier who had mixed with her crew died in the fort which had been occupied by them. Other soldiers then fell sick, and the fort was abandoned. The fever still spread.

From the 20th September, when the first soldier was attacked, to the first week in December, the {103}
fever continued to rage, and at that period it had found its way into almost all the country villages. The fever was believed to be the genuine black vomit fever; it proved contagious almost without exception to the nurses of the sick.

This is an abstract of Mr. Rendell's letter to Lord Aberdeen, Mr. Rendell being British Consul at Bona Vista.

Now at the time the fever broke out in the island the weather was extraordinarily hot, and much rain had fallen, and the town itself was badly drained and in a filthy state; can it be imagined then that the seeds of a disease liable to assume a pestilential character should lie dormant or be annihilated under circumstances the most favourable for their development, especially when we know that endemic diseases may assume a malignant character?

This is just one of many cases which confirm our opinion in this respect, that plants and diseases are not long in making their appearance where the soil and atmosphere are congenial.

The tenacity with which the disease attached itself to the Eclair is sufficiently explained in the absence of due ventilation; in fact, that in the first instance there was no ventilation at all in the hold of the ship. This also the more readily affords a clue to the disaster through all its stages, first in the contraction of the disease as an endemical affection in the vessel; secondly, in the multiplication of the germs in the damp ill-ventilated hold, in a warm climate; and thirdly, the {104}
persistence and entire localization of the disease to the vessel when it arrived in the climate of the British shores; while, fourth and lastly, in the unusually hot and damp island of Bona Vista, the seeds of the disease were sown, and, as we might expect, multiplied indefinitely.

The consecutive attacks of the crew of the Eclair shew that here a noxious gas or a vaporized inorganic poison could not have been the cause of the disease, for as I have before said, in this case the attacks should have been simultaneous; we find, on the contrary, that as the depressing effects of the melancholy condition of the crew was almost hourly undermining the health of the stoutest of them they as surely became the victims. The Kroomen, or natives on board the ship had not suffered, shewing that they were inured to the miasm, or were destitute of that condition of blood which would be favourable to a propagation of the materies of the disease.

The Eclair we learn had left Bona Vista eight days when the first victim breathed his last; this would give perhaps three or four days for the incubation of the disease in the patient, or supposing he had not contracted the germs of the disease before the crew of the Eclair left the fort, some local favouring conditions were the means of keeping the germs in a fertilizing state, for it is clear from this spot the infection spread as from a centre or focus. Such instances as {105}
these might be multiplied to extend the length of the enquiry, but, I think, to little advantage. The chief facts to be gathered are that an endemic affection became epidemic and pestilential, contrary to its usual mode, for the Portuguese official physician, on being consulted by the Governor of the Island as to the safety of landing the contaminated crew, said, "No danger at all; I have often brought sick men on shore coming in vessels from the African coast, and I never knew any ill effects to arise." Putting the most reasonable construction on this emphatic and straightforward language, we may presume that ordinary, remittent, and yellow fever had been commonly imported into the island, for it is not to be supposed but that both forms of disease must have existed among those sick men who had "*often been landed*," under the sanction of the Portuguese physician.

To take another instance; intermittent fever or ague, is a disease known among almost all nations of the world, but it usually occurs in the endemic form only. It is universally supposed to depend entirely upon marsh effluvia, and we are accustomed to consider it as attaching only to low lying countries;[40] but this is not always the case, for disease in this respect, like vegetation, may be {106}
found in various latitudes, to accommodate itself at varying altitudes, to the temperature and climatic relations, so as to appear indigenous. But though our prejudices are in favour of a simple miasmatic source of ague, as its sole cause, there are some who believe in its infectious nature. M. Sigaud, in his work on the Climate and Diseases of Brazil, speaks of Epidemics of *grave intermittent Fever*, and Dr. Copland says, that the epidemic prevalence of ague is a better established fact than its infection, and has been admitted by most writers.[41] We have, therefore, but to go one step further to arrive at infection, after having found that an endemic disease under peculiar circumstances, though but rarely, becomes epidemic. The number of persons attacked {107}
by ague in a malarious district, in proportion to the population, is not so great as might be expected, considering that they are always subject by night and day, more or less, to respire the air containing the germs of intermittent fever; we might, therefore, deny the paludal source of the affection, as reasonably as deny infection, if we found that occasionally, persons, though

subject to all the usual influences, yet escaped all injurious consequences.

There are grades and varieties of infectious diseases, from the most inveterate to the most mild and doubtful; but that all, without exception, which can in any way be traced to a specific generating and organic cause, may assume an exalted infectious character, and that the most inveterate, on the contrary, may more resemble the mild and doubtfully infectious forms, is a conviction that must be forced on all who pursue this enquiry with unbiassed interest.

CHAPTER III. {108}

THE REASONABLENESS OF THE APPLICATION OF THE FACTS TO THE INFERENCE.

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SECTION I.

THE CHEMICAL THEORY OF EPIDEMICS UNTENABLE.

It has been inferred that the germs of disease possess the property of vitality, and a number of facts have been adduced to support the proposition that vitality is the indwelling force by which the matter generating epidemic and endemic disease exercises its influence over man and animals. The reasonableness of the application of these facts to the end in view has now to be considered. Chemistry cannot account for epidemics.

Our first subject of reflection points to the chemical discoveries of the last few years, and particularly to those of the great German chemist Liebig. We find in the first paragraph of his Organic Chemistry applied to Physiology and Pathology, the following words: "In the animal ovum, as well as in the seed of the plant, we recognize a certain remarkable force, *the source of growth* or increase in the mass, *and of reproduction* or of supply of the matter consumed; a force in a state of rest. By the action of external influences, by impregnation, by the presence of air and moisture, the condition of static equilibrium is disturbed. This force is called the *vital force*, *vis vitæ*, or vitality." {109}

The doctrine of Liebig, that the vital force manifests itself in two conditions, or rather, that it is known to be in two different states, that of static equilibrium as in the seed, and in a dynamic state, as in that of growth and reproduction, is perfectly applicable to the germs of disease; the static equilibrium is referrible to the matter of vaccine lymph when dried and preserved for use, and the dynamic forces of the matter are known to be in operation during its reproduction and growth in the system of the vaccinated child.

Then as to reproduction of matter by any chemical process, our author can furnish us with no examples, for even in his explanation of the causes of disease he is quite silent on this point, merely acknowledging that diseased products must be either rendered "harmless, destroyed, or expelled from the body." He further says, that "in all diseases where the formation of contagious matter and of exanthemata is accompanied by fever, two diseased conditions simultaneously exist, and two processes are simultaneously completed," and that it is by means of the blood as a carrier of oxygen that neutralization or equilibrium is established. Liebig thus admits that an agent exists in the blood, capable of deteriorating it at the expense of the oxygen, which he maintains is contained in the red globules; he further acknowledges that two processes of diseased action are going on at the same time, and though he does not explain them, I imagine {110} him to mean that new contagious matter is generated and eliminated from the blood, and that at the same time, there is that condition of body which he would call simply a diseased state, and characterizes it thus: "Disease occurs when the sum of vital force which tends to neutralize all causes of disturbance, (in other words, when the resistance offered by the vital force) is weaker than the acting cause of the disturbance."

If I rightly apprehend his notions, they perfectly harmonize with my ideas, to a certain extent, on the subject. They accord, at any rate, most completely with the theory attempted to be established, and fully confirm the reasonableness of the application of the facts recorded to the inference drawn from other sources. The difference only rests on the question whether vitalized or non-vitalized matter is the *fons et origo mali*.

How is the production of new matter, resembling that originally causing the disease, to be explained by any known hypothesis, except on the assumption of living organized matter? Though Liebig and Mulder both deny the fact, that the Torula cerevisiæ is the sole agent in the process of fermentation: they both equally fail in shewing upon what it does depend, and their difficulty rests entirely on their incapacity to explain the uniform reproductive properties of the matter engaged in this, as well as in all other allied operations. Liebig's statement however on this {111} matter requires notice—he says, "that *putrifying* blood, white of egg, flesh and cheese, produce the same effects in a solution of sugar, as yeast or ferment. The explanation is simply this; that ferment or yeast is nothing but vegetable fibrine, albumen or caseine, in a state of decomposition."

This state of decomposition, however, involves a much more complex proceeding, than simply a reduction of matter into its elementary forms of gases, earths, and minerals; for we nowhere find decomposition of this kind going on without the development of some organized bodies, either animal or vegetable: and since we have seen that the spores of the cryptogami are always in

existence in the atmosphere, and making their appearance under favouring conditions, and especially when we find that fermentation is invariably accompanied, and I may safely say, preceded by the deposition in the fluid of the sporules of the Torula, we can hardly believe that they are any other than the sole agents of the process. I have now a considerable quantity of the Torula obtained from the urine of a diabetic patient, in which they appeared, as it were, spontaneously. After the urine had been allowed access to the air for a certain time, and the whole of the saccharine matter was converted into new compounds, reproduction of the Torula ceased;—and those which remained when the process was completed, still continue as organic cells, deposited in the bottle in an inert state, but ready, on the addition of fresh sugar, as has {112} been proved, to resume an active existence. These germs, it is now well known, may be dried into powder, so as to be blown away like dust without any, or but little, detriment to their vital energies; and there is now no doubt that they exist in this condition in the air, as do the spores of mucor, aspergillus, oidium, agaricus, and all other fungi.

Mulder, however, does allow some properties to the yeast vesicle; he says, "a variety of strange ideas have been entertained respecting the nature of yeast; recent experiments have convinced me that it undoubtedly is a cellular plant consisting of isolated cells. They resemble the composition of cellulose in some respects, but differ from it in many." "These vesicles, consisting of a substance resembling that of cells, do not contribute in the least to the fermentation, but are exosmotically penetrated during fermentation by the protein compound." These chemists seem to have an instinctive horror of allowing any active properties to the yeast vesicle, that is as far as the conversion of sugar into carbonic acid and alcohol is concerned in the act of fermentation. Dr. Carpenter, as if desiring to conciliate the chemical and physiological disputants, considers that the truth is to be found in the mean of the two extremes,—that is, that the process of fermentation is neither entirely dependent on chemical laws, nor on those laws which preside over the growth of reproductive matter, but is a process in which both perform certain offices, {113} each depending on the other to produce the combined result; he thus approaches more nearly to the theory of Mulder, than that of Liebig.

But to revert to Mulder, he speaks of the Torula cells being "exosmotically penetrated during the process of fermentation by the protein compound." Now the Torula is acknowledged to be one of the Fungals, and the chemical constituents of the Fungi approach very nearly that of animal tissues. They contain a peculiar principle, residing in and obtainable from them, termed Fungin, which is as highly azotised as animal fibre. The protein compound alluded to, Mulder says, is not gluten, because insoluble in boiling alcohol, and not albumen, because it is very readily dissolved in acetic acid, and he regards it as a superoxide of protein. This superoxide of protein can only have been produced by a vital action in the cells of the Torula, and as the fungi consume oxygen, and give out carbonic acid, we clearly have all the elementary conditions for their growth in almost all decomposing animal and vegetable matters. It is the nature of the fungi to live on organized matter, but always when it has a tendency to decay; it is for this reason they have been called "Scavengers." Again, we can understand why some animalized or nitrogenous matter should be necessary for fermentation, otherwise fungi could not grow, nitrogen being an essential constituent of their structure, and further fermentation does not commence without the {114} presence of oxygen, and like as in animals, this gas supports their existence. The conversion of sugar into alcohol is represented by the following formula:—

		Result.	
	Sugar.	Alcohol.	Carbonic Acid.
Hydrogen	3	3	
Oxygen	3	1	2
Carbon	3	2	1

If therefore the process were merely of a chemical nature, where is the necessity for atmospheric oxygen to accomplish the end? it is quite certain that fermentation cannot go on without its presence. Let us compare the action of ferment or yeast in a dried state to the action of albumen, which Liebig says is sufficient when decomposing to set up fermentation. "The white of eggs when added to saccharine liquors requires a period of three weeks, with a temperature of 96° F. before it will excite fermentation."[42] But any saccharine liquor on exposure to the air, though entirely destitute of albumen or gluten, will ferment, and the Torula may be found in it. I have found the Torula in a great variety of syrups which have spontaneously undergone fermentation. I have also discovered that the development of the cells is delayed or accelerated by the nature of the ingredient used in flavouring the syrups, with other peculiarities which need not here be {115} mentioned.

But the conversion of starch into sugar by means of gluten requires some notice, as by some persons it is associated in their minds with the organic process of fermentation.[43] Mulder ascribes the latter in the first instance to the action of heat, evidently believing that the pseudo-catalytic operation of gluten upon starch is the type of all such actions, and regarding them all as simply chemical, but we here distinguish a wide difference; in the latter instance the gluten is decomposed, and rendered unfit for a repetition of the chemical phenomenon, and if it is desired to renew the action fresh gluten must be obtained, and a certain temperature kept up, otherwise the experiment fails. How different is fermentation: in the ordinary temperature of the atmosphere the yeast vesicle will multiply, no incremental or unnatural addition of heat is requisite, and it is one of the commonest and most natural instances of vegeto-chemistry: the grape cannot shed its juice, nor the sugar cane its sap without admitting these germs, which,

under certain conditions multiply themselves and convert the saccharine elements into new compounds. The method by which the conversion of starch into sugar is accomplished is thus described by Dr. Ure. He says that if starch one part be boiled with twelve parts of water and left to itself, water merely being stirred in it as it evaporates, at the end of a month or two in summer weather it is changed into sugar and gum, bearing certain proportions to the amount of starch used. But "if we boil two parts of potato starch into a paste, with twenty parts of water, mix this paste with one part of the gluten of wheat flour, and set the mixture for eight hours in a temperature of from 122° to 167° F. the mixture soon loses its pasty character, and becomes by degrees limpid, transparent, and sweet, passing at the same time first into gum and then into sugar."—"The residue has lost the faculty of acting upon fresh portions of starch." {116}

Four points of contrast present themselves for notice as elements of comparison with true fermentation. 1st. The starch solution has to be boiled, so that heat, by which it is to be supposed that the starch globule is ruptured, seems to be an essential portion of the chemical change, and even this may in fact alone be sufficient in such a case to produce some elementary change in the starch, and may prepare it for the subsequent catalytic action of some related organic, though not vital material.[44] 2nd. Not only a summer heat is necessary, but a period of one or two {117} months time must elapse before the starch with the water simply becomes converted into sugar, and if artificial heat is to be used to hasten the operation, a temperature from 122° to 167° F. must be resorted to in order to obtain the desired result. 3rd. When even this is accomplished there is no reproduction of the fermenting matter, and artificial and chemical means must again be applied to repeat the experiment. 4th. The conversion of starch into sugar can be accomplished without the presence of gluten at all, by the aid only of temperature and time. It seems to me, therefore, to be entirely unnecessary to occupy more space in the elaboration of a proof of the doctrine that the germs of the Torula are the sole agents in the conversion of saccharine fluids into alcohol and carbonic acid. By another chemical process starch can be converted into sugar, but I am not aware that hitherto any method has been discovered by which sugar can be converted into alcohol except by the process of fermentation proper.

I have been thus particular in commenting on this subject, as it bears, in an especial manner, on the question under consideration.

The physiologist cannot afford to lose this process from the category of chemico-vital, or {118} biochemical manifestations.[45] The philosophy of the age has a tendency to make every thing chemical; it is true that the Divinity is as much seen in the laws which govern the elementary particles of matter, as in those laws which preside over the transmutation and sustentation of those elementary and inorganic particles, when compounded in the tissues which are engaged in the formation of living beings. The laws by which acids and alkalies neutralize each other, and the affinities single, double and elective, which the particles of matter exhibit, together with the influences of light, heat, and electricity upon almost every condition of matter, are as truly wonderful as the creative power. Man may, in many instances, imitate the processes of nature, he can render iron magnetic, and form alkaloids, but the laws which govern the particles of matter {119} are still the secret of the whole proceedings. We do but interpret the language of nature in discovery, the book is ever open before us, and every atom of the world is a word and a theme, capable of occupying the short span of sublunary existence allotted to man. We have read of "sermons in stones," but a book has been written on a "pebble."[46]

To return, as we every where in nature find a gradual transition in the forms, arrangements and properties of matter, so we may expect to find a link between the inorganic and vital chemistry of nature. The fungi, by which we contend this transition appears to be accomplished, are also a link in chemical composition, between the animal and vegetable kingdom, and not only in that, but in their subsisting upon matter which has been organized, they are deoxidizers and reducers, as the vegetable kingdom in its highest function is a compounder. To their functions and offices in the great scheme of creation, we may fairly apply ourselves with a sure and certain result of the most interesting discovery. Is it no hint that wherever decaying organic matter is found, there do we find fungi? is it no hint that they are found in all parts of the world? that even in snow the germs of fungi will grow and multiply to such an extent, according to Capt. Ross, that the protococcus was seen by him, clothing the sides of the mountains at Baffin's Bay, rising, according to his {120} report, to the height of several *hundred feet*, and extending to the distance of *eight miles*?

Even stones contain in their interior, or interspaces of their structure, the germs of fungi. A species of Tufa is found in the vicinity of Naples of a porous texture, which, when moistened and shaded, produces vast mushrooms, four or five inches high, and eight or ten inches broad.[47] This author further says: "In the Maremma, where the volcanic tufa is the basis of the soil the surface is intermixed with the animal remains of departed empires, and the ordure of cattle, is covered with grasses of old pasturages, and is wet with heavy dews. Everything, therefore, conspires there to a fungiferous end."

They are found growing in and upon both vegetables and animals. Nees von Esenbeck imagined, that minute forms multiplied themselves in the atmosphere; and really, when we consider the amount of effluvia composed of the atoms cast off from the bodies of living or decaying organic matters, which are incessantly passing into the atmosphere, the conjecture is not an unreasonable one. The minuteness of those, which we know are always found growing on decomposing bodies, does not preclude the possibility, nay, further favours the probability, that {121} others infinitely more minute,[48] may be destined to remove the more subtle and vaporous particles which escape into the air.

We can, therefore, I think, conclude, that the lower tribes of vegetation, may consistently be regarded as capable of existing in almost any condition, and almost under any circumstances, they may be made to grow in plants by inoculation, as shewn by De Candolle, and Dr. Hassall. If the stem of wheat also is inoculated with vibriones, they will make their appearance in the grain. [49] If the seed contain them and have not lost its germinating properties, these worms will be found again in the grain. If the grain containing them be dried for years, and moistened again with water, these animalcules, according to Bauer and Steinbach, will present all the phenomena of life. This experiment I have witnessed, and can confirm the statement. These animalcules in the diseased grain, have under the microscope the appearance of an immense number of eels {122} crowded together in a small space, and presenting a movement more, perhaps, vermicular than any other, and it is continued for a considerable time. Now if these animalcules, or their ova, can be proved to pass with the sap to the seed, there can be no difficulty in comprehending how germs, considerably more minute and of a vegetable nature, should be found subject to the same peculiar mode of obtaining an entrance into animals and vegetables for sustenance. "It is usually imagined," says Dr. Carpenter, "that the germs liberated by one plant are taken up by the roots of others, and being carried along the current of the sap, are deposited and developed, where vegetation is most active."

The chemical theory of disease would be better sustained by a comparison of "the artificial formation of alkaloids," and the phenomena of transformation of blood into the tissues of animals, and their degeneration into effete matters, and of sap into the tissues of plants and their degenerations.

Professor Kopp of Strasburg, says, "In a chemical point of view, the alkaloids are remarkable for their composition, for their special properties, both physical and chemical, and for the interesting reactions to which many of them give rise, when exposed to the influence of different reagents. Considered medically, the organic bases are distinguished by their energetic properties. They constitute at the same time, the most violent and sudden poisons, and the most valuable and {123} heroic remedies."

Upon this very intricate and interesting part of chemical philosophy, it is rather dangerous to enter without a thorough and practical knowledge of the subject. This, however, falls to the lot of few men. We, who are engaged in the study of disease, and of the best methods of cure, are obliged to take the investigations of the analytical chemist, and examine them for ourselves in the intervals of leisure allowed us during the active exercise of our calling. Though with less advantages for the study of these transcendental relations of organic and inorganic matter, we are not, nevertheless, precluded from forming our opinions on their practical bearings to the phenomena and treatment of disease.

That there is a matter of a poisonous nature concerned in the production of endemic and epidemic affections, cannot be doubted by any one; I believe indeed, that the chemical theorists admit this, at all events Liebig does, for he says, "The morbid poison changes in the blood are fermentative, just such as occur in beer making." If we start, then, with the consideration that poisons, in a chemical point of view, are the objects of our research; the obvious course to take is to enquire what is the source of poisons generally, and what their effects on the animal economy? The mineral poisons are entirely excluded from the enquiry by their inaptitude for diffusion, and {124} their uniform effects upon all persons, differing only in degree in their operation. The same objections apply to gaseous poisons, except that to them the property of diffusion would be admitted.[50] We come then to the alkaloids, which constitute, as Kopp says, the most violent and sudden poisons. For the production of alkaloids by artificial means, organic products of some kind are required. Artificial heat, powerful chemical agents or length of time, are, as far as information at present extends, the indispensable requirements to induce these peculiar changes in matter. The only instance I can find, in which elementary matters can by artificial means be combined, so as to resemble the products of nature, is that of the conversion of carbon and nitrogen into cyanogen. But the process by which this is accomplished, leads rather to doubt whether it be really and simply by a combination of *elementary* carbon and nitrogen. I extract the following from the Annual Report of the Progress of Chemistry, for 1848. "H. Delbruck has performed some experiments on the important subject of the formation of cyanogen. He confirms the statements of Desfosses and Fownes, inasmuch as a *weak but distinct* formation of cyanogen was observed on igniting *sugar-charcoal*[51] with carbonate of potassa in an atmosphere of {125} nitrogen." The use of sugar-charcoal, may be perhaps an explanation of the weak formation of cyanogen, for in these numerous and successive chemical changes of matter, it is impossible to say how many sources of error may arise. The constant contradictions of each other, and the opposite statements made by chemists, of equal eminence, leave us in a wilderness of doubt, from which we are not likely to be freed, until definite laws shall be discovered to act as a guide in the comprehension of the higher branches of Chemical Philosophy.

But supposing that the generation of alkaloids could take place in the body, or some analogous poisonous matter, we have yet to imagine a whole host of peculiar and essential conditions to effect this change, besides an atmospheric agent or agents to set in motion those compositions and decompositions, capable of bringing out these new products from the elements of blood. We are aware that in the blood, carbon and nitrogen are sufficiently abundant as well as saline compounds, to generate cyanides, and, with hydrogen also there in plenty, hydrocyanates, and thus from them many other poisonous products, but how is all this to be effected? And even if effected, it is yet a question if such compounds can in any way simulate the attacks of epidemic disease. We have already shewn that the amount of most poisons necessary to destroy an {126}

individual, can be pretty clearly estimated, and their *modus operandi* is tolerably well understood. Again, the most essential part, in which all chemical theory fails, is an explanation of the reproduction of contagious matter.

The catalytic process, by which decompositions are said to be effected, and in which Liebig includes the various fermentations, is one of those chemical relations of matter to matter, considered by some as the probable cause of infection. Mr. Simon, in a late lecture, has said, "I consider the phenomena of infective diseases, to be essentially chemical, and I look to chemistry to enlighten the darkness of their pathology. Qualitative modifications, affecting the molecules of matter as to their modes of action and reaction, are such as form the subject of chemical science; and those humoral changes which arise as the result of infection clearly fall within the terms of its definitions." Further on he adds: "The phenomena of infected diseases appears then, in many respects, to be sui generis. Certainly they are chemical. *Probably* they belong to that *class* of chemical actions called *catalytic*."[52]

It is not improbable that something resembling a catalytic action may take place in the blood in {127}
those diseases of endemic and epidemic origin, but that it can be by a chemical process alone is contrary to all experience of catalytic operations, for except in the instance of fermentation proper, there is no multiplication of the fermentative matter. The action of the matter of contagion seems to stand on the confines between electro-chemical and bio-chemical manifestations, and so long as no chemical explanation can be given for the multiplication of the matter of infection, the most rational course to adopt is to assume that life under some unknown form is, as we every where find it, the sole reproductive agent.

SECTION II. {128}

THE ANIMALCULAR THEORY OF EPIDEMICS UNTENABLE.

The animalcular theory of disease, after remaining almost unnoticed for nearly two centuries, has been again revived under the auspices of Dr. Holland in this country, and Henle of Berlin. And though not entirely buried in obscurity, this theory had completely failed to modify the practice of physicians in the treatment of those diseases which were supposed to owe their existence to these invisible atoms of created being. The resuscitated notions and all their amplifications, to which the advance of science has contributed so much, are threatened with a like fate, an absence of all practical results.

Though I would not attempt to deny the possibility, nay, even the probability, that insect life may
yet be discovered as the cause of some diseases,[53] still there are many and cogent reasons {129}
against both, and which are at variance with facts and observations. Where insect life has been found associated with disease, it more especially appears as a consequence than as a cause.

Disease, in its most enlarged sense, is a conversion of one form of matter into another; it is a transformation of healthy blood and tissue into new and abnormal products. Where insects in all their variety of forms are discovered, their voracious propensities are their chief characteristics, they are the consumers of matter after its partial disintegration, if animal matter be their food, unless they be carnivorous and predacious, or if herbivorous they usually feed upon the tender shoots of plants. Thus far we are certain of the manner in which insects destroy living matter; it is a process the unassisted eye may every where witness, and which experience has amply attested. To take, however, the animalcular world as it presents itself to us under the microscope, and as the intermediate step between the manifest and the hidden for a fairer and more direct method of reaching the truth, what do we observe to be the ruling law of infusory instinct? They live to feed; the term polygastrica sufficiently implies their natural tendency to consume. The simplest form of animalcular life, seen in the genera of monads, still preserves the animal character by possessing a stomach or stomachs in which the food is received, to be digested for
the nourishment of the system; and even some of these minute objects which vary in size from {130}
one *two-thousandth*, to one *three-thousandth* of a line in diameter, are said to be carnivorous and predacious. Upon this fact alone, I would place the improbability of insects being the cause of epidemic disease. Each insect doubtless has its own peculiar food, and whether it be a vegetable or animal feeder, it consumes the matter already organized for conversion into its own tissue, and the only change which could be affected by them in the blood, would necessarily be that of appropriation of some one of the constituents as an element of food; when that food is digested, (taking digestion generally as an identical process,) the excrementitious matter is composed of secretions and disorganized matter, mixed together as an *effete* product, and destined then for reorganization by the vegetable kingdom. Now all animals, whether they be large or small, live on organized matter,—they convert that matter into an inorganic form, and I cannot help imagining that if epidemic diseases and fevers depended upon animalcular growth and development in the blood or tissues of the body, the excretions or secretions from them would have yielded some information to the searching enquiries of the chemist, supposing that these excretions and secretions were capable of reaching to a sufficient amount in quantity, to bring about those fatal effects of poisoning, we witness in Cholera and other epidemic affections.
Insects, I believe are poisonous only by their secretions, and though they are known to multiply {131}
with exceeding rapidity, I can hardly imagine that by their development, however rapid, they could produce such a change in the human body, as to bring about the speedy dissolution, and generally gangrenous appearance, that has invariably been observed in those suddenly dying under the influence of epidemic poisons. The vibriones, whose destructive effects on wheat are so well known, are a genus of animalcules, which at first would seem to favour the animalcular

theory in a remarkable manner; for on examining them, they do not appear to possess any other structure than a gelatinous absorbing mass, in this respect resembling a vegetable.

But Ehrenberg's scrutiny corrected the error of De Blanville, and shewed, that they were far from being agastria, or stomachless animals. The Rev. William Kirby says, "Ehrenberg has studied the vibriones in almost every climate, and has discovered, by keeping them in coloured waters, that they are not the simple animals that Lamarck and others supposed, and that almost all have a mouth and digestive organs, and that numbers of them have many stomachs." All the discoveries indeed which have been made on the minuter forms of animal life, have tended to confirm the doctrine that the stomach is the exponent organ of an animal; that is, in all animals there exists, in a variety of modified conditions, a receptacle for food. Some of the animalcules, however, are {132}
still supposed to exist by absorption, as the vinegar eel, *vibrio anguilla*,[54] but when we find that the law is, generally speaking, that the receptacles of food become multiplied in number in these minute beings, and the vibriones which were supposed to be stomachless, have been proved to emulate their associates in the number of these organs; it would be more reasonable to conclude that our imperfect vision is the barrier to their detection, rather than to suppose that they do not exist. Besides, when we are told on undoubted authority that some of the animals of this class, have as many as *forty or fifty* stomachs; the least we can do, is to allow that all of them possess, at least one digestive organ, though we may not be able to detect it.[55]

So far then for the consideration of animalcular structure: let us now more particularly enquire into their destructive habits, and their functions, inasmuch as they may be supposed capable of {133}
engendering epidemic diseases and fever. The truly carnivorous animalcules, or those truly herbivorous in their instincts, we may presume to be beyond the limits of our enquiry. We have rather to do with those which take an intermediate position, namely, those which feed upon matter undergoing decomposition, or upon fluids containing organic matters in solution, or suspension. If we take Entozoa generally, they may be considered as most conveniently to be placed in this intermediate class; and here we find still the digestive apparatus, and more than this,—for upon the modifications of the organs appropriated to digestion is their classification founded. "Rudolphi divided the Entozoa into Sterelmintha, or those in which the nutrient tubes without anal outlet are simply excavated in the general parenchyma, and into the Cœlelmintha, in which an intestinal canal with proper parietes floats in a distinct abdominal cavity, and has a separate outlet for the excrements."[56]

How do these animals obtain their sustenance, and what changes can they produce upon the vital fluid of the body? Analogy is here our only guide. If the trichina spiralis is examined, it is found to be enclosed in a cyst containing fluid; and this is, doubtless, the source of its nutriment, and {134}
contains in solution the elements for its nutrition; but in this instance there is no selection, and there can be no locomotion to an extent sufficient to imply searching for food, as the animalcule in its natural state, when taken from the human muscle, is found coiled upon itself, making about two and a half turns. The fluid of the cyst is thus in all likelihood prepared by endosmosis, for the immediate and appropriate nutrition of the parasite. The cyst is thus the part which performs the diseased process, the containing animalcule is merely the consumer of what is prepared for it by the cyst. And this would seem to be the rule with all parasites, of the encysted kind.

We have alluded to the vibriones which are found in the fluids of living bodies, and the trichina which is found in the solid muscle; we have now to refer to those which infest the cavities. It was, I believe, Ehrenberg, who shewed that the tartar which accumulates on the teeth is composed of the debris of minute animalcules; in fact, that it consists of calcareous matter, having once formed a portion of the structure of their bodies, the ubiquity of these creatures is therefore as much and clearly established as the lower forms of vegetation. The intestinal worms, of which perhaps the Tænia is the most curious and important to be noticed, are from the locality in which they are found, chiefly injurious by the irritation they set up, and by appropriating to themselves {135}
the nutrient juices elaborated in the process of animal digestion, thus depriving the individuals they infest of that which was destined for their own nourishment. In this, as in all associated instances, the character by which these parasitic animals are marked is their consuming propensity. There is, however, one more observation to make upon parasitic growths; but the question is yet unsettled in what kingdom of nature is the acephalocyst, or hydatid, to be placed. Mr. Owen says, "As the best observers agree in stating, that the acephalocyst is impassive under the application of stimuli of any kind, and manifests no contractile power, either partial or general, save such as results from elasticity, in short, neither feels nor moves, it cannot, as the animal kingdom is at present characterized, be referred to that division of organic nature."

We thus arrive at the simple cell, and the multiplication of living beings by cell buds; it is the point at which the confines of the animal kingdom are reached, and at which we are driven to speculation. The hydatid lives like a plant, by imbibition; and procreates, like a plant, by budding, either endogenously or exogenously, as regards the original or parent cell.[57]

This condition of being, suggested the notion of Protozoa, or first animals, in the same way that {136}
the purely cellular plants, that is, each individual, consisting of a single cell, gave the idea of Protophyta, or first plants. Mr. Kirby thus expresses himself on this subject: "The first plants, and the first animals, are scarcely more than animated molecules, and appear analogues of each other; and those above them in each kingdom represent jointed fibrils."

Admitting, then, that animals as well as plants exist in the form of simple cells, and that their multiplication proceeds apparently upon the same principle in each, it is nevertheless abundantly

manifest, that the cellular form of perfect individuals is infinitely more numerous in the vegetable than in the animal kingdom.

From the mosses downwards to the fungi, the whole structure of the plants consists of an {137}
aggregation of cells, more or less in number and complicate arrangement, until, through a variety of gradations, we reach the single cell as a perfect individual.

It is rather remarkable, that the lower forms of vegetables and animals seem to derive their nutriment from matter of a similar kind; and though the office of plants is as a rule, to convert inorganic into organized matter, it appears that some of the fungi may live as animals do on organic matter when in a state of solution. This, however, is uncertain; for we do not know what are the first signs of decomposition in organized bodies, and for aught we can tell, it may be perpetually going on; so far as the disengagement of carbon from the system is concerned, this is certain; but whether the nitrogenous compounds also are subject to a resolution into their elements in the living body, is another question, and not so easy of solution. The partially decomposed elements of animal structures are, however, particularly adapted for the nutrition of the lower forms of vegetation; it is, indeed, from the decaying organic matters that the fungi derive, it may be said, their entire food.

SECTION III. {138}

SKETCH OF THE PHYSIOLOGY AND PATHOLOGY OF PLANTS AND ANIMALS.

Animals and plants depend for their existence upon a nutritive fluid, which permeates their structure; it is the element from which all their secretions are formed, and their organs are nourished.

The food of animals is composed of previously organized matters, and is conveyed into a reservoir called a stomach, where it undergoes a process of solution, previously to entering the circulation. At this period, the animal and the plant again present points of resemblance, the lymphatics or absorbent vessels take up the products of digestion, and convey them to the blood-vessels, where mingling with the current of the blood, they are conveyed to the lungs, there to undergo a process of oxygenation before they become fitted for the renovation of the tissues of the body. Such is the nature of the food of man, that it contains all the elements necessary and adapted for transformation into bone, muscle, brain, and parenchyma, as well as the other tissues of the body; besides other elementary matters, which, though they form a very insignificant portion of animal textures, from their constant presence in the vital fluid, evidently perform some important {139}
offices in the general economy of life; they are partly, perhaps, occupied in forming constituents of secretions.

Plants do not require a stomach,—the humus or soil to which they are fixed is the laboratory, where the nutritive matter is prepared in a state fit for absorption by the spongioles of their roots, and these correspond to the lymphatics of animals; after being taken up by the spongioles, this new fluid mingles with the sap, and passes to the leaves or breathing apparatus of plants, where carbonic acid gas combines with the crude vital liquid, and converts it into a condition fit for all the offices to be performed by the plant: viz. the growth of tissues, and the elaboration of secretions.

The tissues, however, of plants, though more simple in their nature, present a much more varied character than those of animals, when the different species are compared.

The bones of animals which give them their form, are invariably constituted of phosphate and carbonate of lime, deposited in a matrix of gluten; muscle, nerve, brain, tendons, and ligaments, have nearly, if not completely, an identical composition throughout the whole range of the animal kingdom: their secretions, however, vary much more considerably, as also do the secretions of vegetables. But vegetable tissue may contain, as in the stems of grasses, a considerable amount {140}
of silex, and some notable quantity of sulphur, and so essential to their existence is the former element, that they cannot live without its presence in the soil, and also with it an alkali, to render it soluble. A large amount of soda, is an invariable attendant upon the structure of marine plants, as potash is of those growing on the land.

Thus, whether we regard the health of animals, or vegetables, we discover, that besides the matters which are absolutely indispensable for the nutriment of the tissues which undergo rapid transformation, those of a more permanent and durable nature require in an almost insensible degree, a restitution of elements; and though not apparently absolutely necessary to preserve vitality in the being, yet have so marked an influence over it, as to indicate an extensive bearing of each individual part, on the whole associated entity.

The elementary tissues of both kingdoms have been traced, in whatever form they may be found, to a cellular origin. The minutest vegetable germ, is a cell containing a granular matter within it, and even man himself, in his embryonic state, may be represented as an insignificant point in the realms of space; and might be placed side by side with the smallest particle of living matter, without suffering by the comparison.

The laws by which the development of these elementary cells is regulated, so that each advances to its limit, and fulfils its destination, is one of those inscrutable and overwhelming mysteries of {141}
nature, which leads the admirer of creation on and on into the abyss of the future, and fills his soul with aspirations for that time, when the veil of ignorance shall be withdrawn. But this is not

my subject.

The organization of the two animated kingdoms, is then regulated by definite laws, and all matter, whether acting upon them as agents of nutrition or destruction, are equally under their dominion; to investigate and to endeavour to fathom some of these laws, is the aim I have in view.

The sap is to the plant, what the blood is to the animal,—the elements of nutrition and secretion are contained in it, and whatever interferes with its normal constitution by subtracting from, or adding to it, deteriorates its qualities, and retards or accelerates the functions of the individual. Excess or deficiency of the natural elements may also be a source of disturbance; if carbonic acid be too abundantly liberated in the soil, as Dr. Lindley expresses it, "plants become gorged;" and if, on the other hand, the elimination be too slow, they become starved. It has been also shewn, that plants though they give out oxygen from their leaves, do not throw it off as animals do carbonic acid from their lungs; but that this arises as a result of digestion, and the fixation of carbon in the system, and that they really respire oxygen as animals do, and give off carbonic {142}
acid, both by day and night.

That light is the stimulant of the digestive functions, and that, therefore, during the day, the amount of oxygen thrown off, far exceeds the amount of carbonic acid liberated during the same period.

The great and important distinction between animals and plants is, that the former possess a nervous system, by which they are subject to a very extended series of psychological relations; it is in these chiefly, if not entirely, that we are to look for the distinctive and well-marked differences of diseased action. In animals there are special media of communication between the sources of dynamic power, and the parts upon which the force is exercised: and again, a return communication exists, which conveys impressions to the source of power, and to use a simple comparison, a system of telegraphing is in incessant and watchful operation. This force is influenced and modified in its action, when exercised in the regulation of nutrition, growth, and reproduction of tissues, by the passions and emotions of the mind. All the secretions and functions of the body are more or less susceptible of being accelerated, retarded or modified by the psychical relations of mind and matter. Though we are apt to imagine that in man alone, these phenomena obtain much importance—there can be but little doubt, that wherever a nervous system exists, whether in the form of aggregated or diffused ganglia, the {143}
interdependence of force and organization, each upon the other, bears a certain and definite physiological comparison; the more aggregated the ganglia, the more close, intimate, and extensive the psychical connexions, and the gradations pass downwards, until they appear to be lost on the confines of the vegetable kingdom.

The diseases of plants and animals deserve a more careful comparison than, I think, has hitherto been bestowed upon them.[58] If the study of physiology, or an enquiry into the laws which regulate the functions of living beings in a state of health, has been materially aided by the intimate knowledge of vegetable physiology, which, from the simple structure of plants, so favours the experiments of the student, there is every reason to suppose that vegetable pathology may also lead us to an equally important and useful result.

It is quite certain, that if a healthy seed, or leaf-bud, be placed in such a situation, that, according to the laws known, it will in all likelihood germinate, if all the elements for its sustenance exist in the soil, and the temperature and hygrometric condition of the atmosphere are adapted to it, a {144}
healthy plant will be the result. Light, heat, moisture, and soil are therefore to be considered as the agents required to exist in a certain balance, or proportion, in reference to the health or power of vitality of the plant. Within a certain amount of variation, health may persist in virtue of the power of selection, which appertains to the spongioles of the root in absorbing nutriment; and also as regards light, from the tendency which most plants have to accommodate themselves to any deficiency of this element, by presenting their leafy expansion in that direction where the most of its influence may be obtained. But beyond a certain limit an unhealthy condition sets in. If the soil contain not the inorganic elements, which are absolutely indispensable for the tissues of the plant, or even if they be there and not in a state to be absorbed, a dwindling and degeneration ensue; if light be deficient in quantity, pallor, feebleness, and elongation of tissue follow, with more fluidity and general softness of texture. These conditions of plants have their analogues in the ill-fed and ill-nourished children in some of our manufacturing districts; they are stunted and diseased. Transport a healthy country lad, with the bloom of health on his cheek, from his native hills and valleys, or woods and fields, to the stool behind a desk for eight hours a day, in a narrow street in any city, where the rays of the sun rarely penetrate, it will not be long before the skin of the animal and the cuticle of the plant may be submitted for comparison, when {145}
both will testify to the importance of the solar rays, as an indispensable agent in supporting the normal processes of organic life. So far common observation is competent to a solution of the facts; but beyond this we come to the enquiry, what resemblances are there in the early conditions of plants and animals. Each originates from nucleated cells, endowed by the All-seeing Power with a blind impulse of progressive development; the most simple cell of a vegetable multiplies itself by a generation of new cells within it, when the parent dies, and liberates the offspring. Here progression is simply multiplication; it is, as it were, progression in length only. The original cell, however, of animals, which is styled the germinal vesicle, extends or becomes developed into dissimilar parts; and whatever may be the variety, all alike proceed from the original germ cell, and the *tout ensemble* of parts constitutes the one and indivisible whole; in this instance there is addition besides multiplication, tissues and organs are added in all variety, until the maximum of organic development is attained in the wonderful being, man.

Yet how many points of resemblance are there between the vegetable cell and the fully developed human being, in a physiological and pathological point of view. There must be nourishment to sustain both; both require a certain amount of light and heat for their growth and increase, and {146} are dependent upon various unknown causes for active and healthy existence; and when a certain time has expired, all alike return to a condition, in which the particles composing them are subject only to the dominion of the laws which preside over inorganic matter.

But during the existence of plants and animals, we discover other features of comparison; plants, as well as animals, are liable to disease; they are subject to functional and organic affections. The former, among plants, are usually traceable to atmospheric vicissitudes or irregularities, changes of situation, &c.; and in man to irregularities of diet, and mental and bodily excesses, as well as to atmospheric vicissitudes.[59]

The organic diseases of plants and animals depend upon a repetition, or continuance, of functional derangement. As a consequence of this, the nutrition and reproduction of tissues lose their normal and definite character, wherefrom an indefinite and abnormal result is obtained. There is a limit to abnormal productions, and they are apparently subject to laws, though not yet {147} understood. In animals, they may be either excessive development of natural tissue in natural localities, as obesity and fatty tumours; they may be natural products in unnatural situations, as fatty degenerations of muscular tissue; or altogether new and unnatural products, as tubercle and cancer.

In plants, from their greater simplicity of structure, organic affections are perhaps entirely limited to the two first forms of animal organic disease; viz. to undue development of tissue in natural situations, and to the formation of natural tissue in parts of a plant where they are not usually found in a state of nature. The variety of excrescences seen on the stems, branches, and twigs of plants, may be given as instances of the former; and the conversion of stamina into petals, as in double flowers, as an instance of the latter.

We derive our sustenance from vegetables, and they from us; they produce for us the soothing opiate and the deadly strychnia; we for them the animating ammonia, and the distortions and sterility of excessive culture; we engender in them, by the latter, debility, disease, and death; and in our turn we become their prey. All this indeed is but a cycle of events, that requires no learned mind to fathom, and to comprehend; it is a matter of every day occurrence, and, though perhaps not entirely unheeded, is not dwelt upon in the fulness of its bearings and importance. {148}

Let us now consider the diseases of plants, as a study progressive to those of man; and as their physiology has so extensively served us, we may possibly also find in their pathology much material for instruction; not that it will be attempted to shew that the same diseases affect both kingdoms, but that diseases, though dissimilar in effects, may have similar sources.

Unfortunately, there are not many men in this country, who need go further than their own gardens to find abundance of disease among their fruit trees and vegetables. The vine, the apple and the potato, common to most gardens, will furnish specimens.

It is an error of a serious kind to suppose, that the parasites which infest plants are not essentially the cause, or, perhaps, more properly speaking, the elements of disease. I confine myself here to disease of parasitic origin, as that is the subject of which I am chiefly treating.

That parasitic growths are the elements of disease in some instances, is now beyond dispute. The experiments of Mr. Hassall, detailed in Part II. of the Transactions of the Microscopical Society of London, are most conclusive; and they are of that simple nature, that any one may convince himself of their accuracy, by a repetition of them from the directions there laid down.

He says, the decay is communicable at will "to any fruits of the apple and peach kind, no matter how strong their vital energies may be, by the simple act of inoculation of the sound fruit with a {149} portion of decayed matter, containing filaments of the fungi. We may use with success the sporules of such fungi; but in this case the decomposition does not set in so quickly; in the one case, the smaller filaments of the fungi have advanced several stages in their growth; while in the other, the sporules have yet to pass through the several stages of their development."

Mr. Hassan, however, seems to speak doubtfully as to the mode in which the disease becomes naturally introduced;[60] how the spores enter the fruit, "is not very clear—though probably, it is by insinuating themselves between the cells of which the cuticle is composed, or perhaps by means of the stomata, where they are present. I may here state that the experiments were made on fruit, while living, and attached to the tree."

But why should there be a doubt as to the parts by which the sporules of minute fungi enter the plant, when it is clear, that not only can they enter by the spongioles, but by the stomata of the {150} leaves, and mingle with the sap. It is true, that they make their appearance and grow upon the leaves and the fruit; but these are the situations most adapted for their fructification. I have seen the spores of the fungi which attack the cucumber and vegetable-marrow, in the cells of the hairs, and even their filamentous prolongations; these appropriate the fluids conveyed to the cells of the hair, rupture them, and at length fructify.

On referring to Dr. Lindley's Medical and Economic Botany, I find that many fungi are the active elements of disease, and in a manner which renders it highly improbable that they are so in any other way, than by obtaining an entrance to the sap of the plants. Of the microscopic fungus which destroys wheat, the Uredo caries of De Candolle, we find the habitat to be within the ovary

of the corn, and that 4,000,000 may be contained in a grain of wheat,—now this and another fungus, the Lanosa nivalis, are said to destroy whole crops of corn: we cannot imagine that such an extensive affection, can have any other source than by means of the spores through the sap, seeing that bruising of the surface, or rupture of the cuticle of the apple, a comparatively soft fruit is necessary to produce the disease artificially in them; besides, a grain of corn containing vibriones, when grown and having fruited, the new fruit also contains them—now here, as this is I believe almost invariably the case, either they or their ova must be carried with the sap to the {151} new germs.

It is rather a remarkable fact, that these entophytes appropriate the nutriment destined for the plant in which they grow, they are consequently the means in many instances of its entire destruction, though only partially so in others.

There are many Fungi which have this tendency. The Puccinia gramienis, "preys upon the juices of plants, and prevents the grain from swelling." The Æcidium urticæ, common on nettles, deprives the plant on which it grows, of the organizable matter, intended for its own nutrition. The Erysiphe communis, overruns and destroys peas. The Botrytis infestans, "attacks the leaves and stems of potatoes." The Oidium abortifaciens, attacks the ovaries of grasses—and the Oidium Tuckeri, "a formidable parasite, destroys the functions of the skin, of the parts it attacks." The latter has been most injurious to the vines, during the last two years. I have known instances in which the vines have been cut down, and every means taken to rid the houses of the disease; but this year, it has made its appearance, with all its former virulence, in the new shoots.

This, however, is sufficient to shew that plants are liable to disease, depending upon parasitic growths, which affect their vital powers, and deprive them of their natural nutritive fluids.

But somewhat similar diseases belong also to warm climates; in a letter from Cuba, dated Dec. {152} 1843,—Mr. Bastian writes, "*a plague* has appeared among the orange trees—a mildew attacking the leaves and the blossoms, which finally dry up. It most frequently kills the trees. None of the orange family are exempt; lemons, limes, and their varieties, with the shaddock and forbidden fruit, have all suffered." This disease has continued without intermission, till the present year,—when the same gentleman writes, Feb. 20th, 1850: "The evil exists, although in a diminished degree, so much so, as to have allowed the trees to produce me 30,000 oranges again. In old times, the same plantations produced me 100,000."

The West India sugar-canes are also liable to a disease, which the Rev. Mr. Griffiths, in his Natural History of the Island of Barbadoes, speaks of, in the following manner: "This, among diseases peculiar to canes, as among those which happen to men, too justly claims the horrible precedence." This disease is called the Yellow Blast. It is difficult to distinguish the Blast in its infancy, from the effect of dry weather.

There are often seen on such sickly canes, many small protuberant knobs, of a soft downy substance. It is likewise observable, that such blades will be full of brownish decaying spots. The disease is very destructive to the canes. It is observed, that the Blast usually appears successively in the same fields, and often in the very same spot of land. {153}

This Blast is often found far from "infected places," and the infection always spreads faster to the leeward, or with the wind.

"*It is remarkable if canes* have been once infected with the Blast, although they afterwards to all appearance, seem to recover; yet the juice of such canes will neither afford so much sugar, nor so good of its kind, as if obtained from canes which were never infected."

I may here allude to the circumstance, that in the island of Cuba, the destructive mildew is commonly called, *la pesta*.

It were needless to multiply instances of other endemic and epidemic diseases of vegetables; they are well known by practical observers to be very numerous, and I believe, in most instances, depending upon fungoid growths. The destruction of vegetables by insects, is of a very different nature to that produced by the fungi; it would be as unreasonable to consider the consumption of corn and herbage by locusts, as a disease of vegetation, as the massacre and devouring of human beings by cannibals, a disease of the human body.

It is true that insects are exceedingly destructive to plants, but as far as I am able to obtain information, they appear to be so chiefly by their voracious propensities; they consume the structure of the plant in its entity, and do not primarily interfere with its vitality. The instance of the vibriones, before-mentioned, seems at first to be an exception to the rule, but this is rather {154} apparent, than real; and it may be made to apply more as a confirmation, than an obstacle to the vegetable theory: for if we may fairly compare the diseases of animals with those of plants, the existence of entozoa in the latter, would be considered an essential point to be substantiated.

Having now considered the question as to the infeasibility of supposing that chemical fermentation is the basis upon which a theory of diseases can be sustained, and having shewn that life is inseparable from infection, and miasmatic generation;—having explained the phenomena of the dispersion of diseases by comparison with the dispersion of plants, and finally, having demonstrated that the physiology and pathology of plants bear so close a relation to each other, and that their epidemic affections depend upon minute organic germs, I submit to the judgment of my readers, whether there is not much reasonableness in the application of the facts to the inference—that living germs are the cause of epidemic disease in man and animals.

CHAPTER IV.

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RESULTS IN PROOF OF THE TENABLENESS OF THE PROPOSITION.

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SECTION I.

OBSERVATIONS ON SOME OF THE LAWS OF EPIDEMIC DISEASES.

The results obtained by comparing certain facts connected with Epidemic Affections of animals, with analogous affections in plants, afford, from the few instances I shall here notice, a very strong presumption, that analogous causes operate in the production of these affections. I have already quoted from Hecker, to shew that previously to, and during the Epidemics of the Middle Ages, the minuter forms of animal and vegetable life appeared to be called into existence, much more abundantly than usual; that famines prevailed in consequence of failure of cereal crops, no doubt depending then, as now, upon the various forms of fungiferous growth. I cannot refrain quoting here, a passage or two from our old friend Virgil; for he confirms not only the fact of peculiar showers in connexion with diseases, but he also refers to the rust of corn, thus: {156}

150. "Mox et frumentis labor additus; ut mala culmos
Esset rubigo ...
... Intereunt segetes."

Georg. 1.

Then:

311. "Quid tempestates autumni et sidera dicam?

. . . . . .

322. "Sæpe etiam[61] immensum cœlo venit agmen aquarum
Et fœdam glomerant tempestatem imbribus atris
Collectæ ex alto nubes."

Georg. 1.

The occurrence of black showers in this country has been observed during the present year, and I understand that in the fenny countries of the East, the corn has suffered much from the Uredo. I am not mentioning the circumstances as cause and effect, but merely to call attention to the fact, that unusual phenomena of this kind have been generally associated with disease of the animal and vegetable tribes.

The same causes also predispose plants as well as animals, to epidemic attacks of disease. The repeated observations in the public journals on the subject of ventilation, drainage, and over-crowding, render all notice from me needless, to shew that these, though they do not produce the diseases treated of, yet that under the influence of bad air, bad drainage, and over-crowding, {157} epidemics are fostered and spread.

Lastly, says the Count Philippo Ré, "I would remark that if *bad cultivation, and especially bad drainage, does not produce bunt or smut, it is certain that those fields, the worst treated in these respects, suffer the most from these diseases*."

It has been remarked by many observers, that a greater fecundity has attended upon Pestilences, and this has been proved by comparison, that the births in proportion have far exceeded the ordinary limit.[62] In juxtaposition with this observation, I will place the following, not as a proof, but as a remark made quite independently of the subject of which I am treating. "From the first the diseased ears are larger than the healthy ones, and are sooner matured. What appears singular, but which I have not, perhaps, sufficiently verified, is *that the seeds are more abundant than in a sound ear*."

Now these are facts which require amplification, and if these two alone should be shewn upon an {158} extensive field of observation, to apply not only to corn, but to other members of the vegetable kingdom, as I doubt not will be the case, though I am not fully prepared to prove it, it would be difficult to dissociate the fertility of the two living kingdoms from the operations of one and the same, or an analogous law.

The epidemic diseases of plants are both infectious and contagious, at times they are observed to be endemic only, and then depending particularly upon some local causes. This is a law of diseases which applies equally to those of men and animals. In connexion with this law is another, which, as far as I am aware, has not hitherto been noticed in connexion with plants. The potato disease, which excited so much interest and created so much anxiety for the poorer classes of society, led the Government of this country to employ the most learned men to investigate the subject, in the hope of propounding some reasons which should explain the cause of the calamity, and thereby deduce a method of eradicating the evil, or, in other words, discover a cure for the disease. Many were the opinions as to the cause of the distemper, which it were

useless here to recount, but a method was suggested, to which most people, I believe, looked forward with great anticipations, and this was to obtain native seed, and to sow it on virgin soil. Was the end accomplished? No. For though the seed was sown, and the plants grew, the disease still appeared among the newly imported individuals, to as great an extent, as among the native or domesticated plants. {159}

As a parallel to this, it may be stated, that, as regards either endemic or epidemic disease, those persons newly arrived, either in a district or country where these prevail, are even more liable to them than the residents.[63] Again, I have learned, that where the potato disease has been so bad as to render the crop almost valueless, the best plan to be adopted is, to allow the plants to remain in the earth, and thus leave such as retain their germinating powers to come up spontaneously the following year. I certainly saw one large field treated in this way, yield a crop almost without disease.

The seasoning, in this instance, seems to bear a comparison with the seasoning of animals and man, under a variety of diseases, which for a time renders them insusceptible of another attack. It therefore does not appear so improbable, that these affections may be regarded, as Unger, the German botanist supposed, the Exanthemata, or Eruptive Fevers of vegetables. {160}

Another feature seems to associate the Epidemics of plants and animals, in a manner suggestive of analogous causes operating in both instances.

The lungs of animals and the leaves of vegetables, are their respiratory organs, by means of which, the blood in the one case and the sap in the other, derive gas from the air, and impart gas to it, each taking what is thrown off by the other.

Now the epidemics among vegetables, have a remarkable tendency to exhibit their effects primarily on the leaves, and particularly on those parts which are appropriated to the function of respiration. It is from the stomates that many of the fungi commence to germinate, and their fructification may be seen sprouting from the opening composed of a chink, surrounded by a peculiar arrangement of cells, which constitute the breathing apparatus of their victim.

In the earlier epidemics, of which we read, one of the most remarkable circumstances, was the extraordinary influence the poisonous matter appeared to exercise over the lungs,[64] and they again, were the means of propagating the disease, and spreading the contagious particles through the atmosphere, for we read: "Thus did the plague rage in Avignon for six or eight weeks, and the pestilential breath of the sick, who expectorated blood, caused a terrible contagion far and near, for even the vicinity of those who had fallen ill of plague was certain death; so that parents abandoned their infected children, and all the ties of kindred were dissolved."[65] "The like was seen in Egypt. Here also inflammation of the lungs was predominant." "Here too the *breath* of the sick spread a deadly contagion." {161}

It is more than probable that all infectious matter obtains an entrance to the system through the lungs. Inspiring the air containing the pestilential semina is, indeed, the only plausible explanation of infection; for though the skin is indubitably an absorbing surface, and capable of taking up and conveying to the blood any noxious matter applied to it, yet it is far more probable that the lungs would effect this process with greater rapidity. Then the stomach, the only other absorbing surface to which extraneous matter can be applied, is not likely to be the part where the elements of disease would obtain an entrance to the system, for many facts prove, that infectious matter may be swallowed without any injurious consequences, unless in a very concentrated state. Instances are not easily found of diseased matter having been swallowed, except where diseased vegetables have formed under some combination of circumstances, a portion of diet.[66] {162}

Many facts are on record which prove the powerful effect of diseased grain when made into bread, and taken for any length time as a principal article of food. The history of Ergot of Rye is too fresh in the memory of most people to require more than an allusion here. The stomach had no power over the secale, its poisonous properties were retained, after having been submitted to the digestive process, as was evidenced by the abortions and gangrenes it occasioned.

But diseased wheat is also capable of inducing gangrene, and it is more than probable, that many diseases might be traced to the use of infected grain of various kinds. An interesting account of a family who lived at Wattisham, near Stowmarket, in Suffolk, and all of whom suffered more or less from living on bread made of smutty wheat, may be found in the Philosophical Transactions. The mother of this family and five of the children, consisting of three girls and two boys, all suffered from gangrene of the extremities; the father lost the nails from his hands, and had ulceration of two of his fingers.[67] Dr. Woollaston wrote thus in a letter on this case: "The corn with which they made their bread was certainly very bad: it was wheat that had been cut in a rainy season, and had lain on the ground till many of the grains were black and totally decayed, but many other poor families in the same village made use of the same corn without receiving any injury from it. One man lost the use of his arm for some time, and still imagines himself that he was afflicted with the same disorder as Downing's family." It is not unlikely this was the case, for numbness and loss of power was one of the well marked characters of the disease. {163}

What other afflictions may be due to diseased vegetation and adulterated articles of food, and what loss of life may accrue from cheap and adulterated drugs and chemicals is hardly yet dreamt of.[68] The systematic practice of adulteration of almost every article of diet which comes {164}

to table has become a serious question for the legislature to consider. Take only the article of milk, upon which the young children of large towns and cities, make their chief meals, with the addition of bread. How much milk comes into London from the country, how much is obtained from stall and grain-fed cows in the metropolis, and how much is said to be consumed, would be an interesting calculation. It is pretty well known that a mixture is sold by which a retailer of milk may increase his supply by one-third or one-half. It was discovered in Paris that the brains of animals, when prepared in a particular manner, formed, when mixed with a certain proportion of milk and water, a very fine and deceptive cream; in that city this system was carried on to a considerable extent. I could not help alluding to these facts while speaking of diseased grain, for who shall say to what extent a miller in a large way of business, may be able to "work in," as it is called, a considerable amount of smutty corn in the manufacture of flour? Now, as diseased grain is known to induce abortion, it is impossible to tell how small a portion may in some cases {165} produce the effect; we may therefore say with Thomas of Malmesbury, "There is no action of man in this life which is not the beginning of so long a chain of consequences, as that no human providence is high enough to give us a prospect to the end."[69]

To return,—associated with these observations are other facts of considerable weight. Before and during pestilences, abortions are more frequent than in ordinary times; infectious and contagious diseases induce abortion; besides this, and independently of disease, conditions of the atmosphere have been known to exist when abortion has been an epidemic affection; of this Dr. Copland says, "to certain states of the atmosphere only can be attributed those frequent abortions sometimes observed which have even assumed an epidemic form, and of which Hippocrates, Fischer, Tessier, Desormeaux, and others have made mention." With this reference I will close the subject of comparison between the affections of the breathing apparatus in animals and plants, merely alluding to the probability that under some conditions of atmosphere, independently of heat, &c. vegetables without any other assignable cause will become abortive.

SECTION II. {166}

WHAT IS THE NATURE OF THOSE POISONS WHICH MOST RESEMBLE THE MORBID POISONS IN THEIR EFFECTS ON THE BODY?

In the early part of this book, I considered the nature of poisons generally, and had occasion to remark upon the characters which separated poisons into two distinct classes. 1st, Those which have the power of self multiplication; and 2nd, Those destitute of this property.

Of the first we have seen that the poisons of epidemic diseases multiply both in and out of the body.

The poisons of infectious diseases, not usually epidemic, do the same. Those of endemic affections, such as ague and some fevers, usually become multiplied out of the body only, but under some circumstances, and peculiar atmospheric conditions, they may be also multiplied within the body. The amount of these poisons necessary to produce their specific effects, may be inappreciable. Of the second class, there are two kinds, those derived from the organic kingdom and those derived from the inorganic kingdom. Of these, the amount necessary to produce their specific effects is appreciable and pretty well known.

But among those poisons, consisting of organic products, there is one which seems to hold an {167} intermediate place. This is derived from one of the Fungals, and as it takes this remarkable position as a link of connexion between the two classes of poisons, I may be excused quoting a passage of some length upon this agent, from Dr. Lindley's Vegetable Kingdom. "One of the most poisonous of our fungi, is the Amanita muscaria, so called from its power of killing flies, when steeped in milk. Even this is eaten in Kamchatka, with no other than intoxicating effects, according to the following account by Langsdorf, as translated by Greville. This variety of Amanita muscaria, is used by the inhabitants of the north-eastern parts of Asia in the same manner as wine, brandy, arrack, opium, &c. is by other nations."—"The most singular effect of the amanita is the influence it possesses over the urine. It is said, that from time immemorial, the inhabitants have known that the fungus imparts an intoxicating quality to that secretion, which *continues for a considerable time after taking it*. For instance, a man moderately intoxicated to-day, will by the next morning have slept himself sober, but (as is the custom) by taking a teacup of his urine, he will be *more powerfully intoxicated* than he was the preceding day. It is, therefore, not uncommon for confirmed drunkards to preserve their urine, as a precious liquor against a scarcity of the fungus. The intoxicating property of the urine *is capable of being* {168} *propagated*; for every one who partakes of it has his urine similarly affected. Thus with a very few amanitæ, a party of drunkards may keep up their debauch for a week."

This property of the amanita, at once places it in a separate category from all other organic poisons, it has yet to be shewn upon what this intoxicating fungus depends for its activity. Whether some secretion is formed in the tissue of the plant, or whether some new arrangement of the particles of matter or modification of the sporules, is brought about by entering the system, it is impossible to say. Langsdorf states that the small deep-coloured specimens of amanita, and thickly covered with warts, are said to be more powerful than those of a larger size and paler colour. As the effect is not produced until from one to two hours after swallowing the bolus, and as a pleasant intoxication may be obtained by this agent for a whole day, and from one dose only, there is a defined line between this and the ordinary narcotics and stimulants in common use. That the digestive powers of the stomach have no influence over the intoxicating

properties of the plant, is manifested in the fact, that the active principle passes into the urine, not only not deteriorated but apparently increased, for, as we have seen, a teacup of the urine from a man, intoxicated by taking the amanita into his stomach, will cause him to be more powerfully intoxicated than by the original dose. We have, therefore, but two conjectures left for {169} consideration, either the original intoxicating principle is excreted from the system in a condensed form, in which case its indestructibility by digestion, makes it approach the ordinary organic poisons, or there must be an increase of the toxic agent, in which case we must suppose a reproductive process having taken place in the system. "There is," says Dr. Mitchell, "in the wild regions of our western country, a disease called the *milk sickness*, the *trembles*, the *tires*, the *slows*, the *stiff-joints*, the *puking fever*, *&c.*" The animals affected with this disease, "stray irregularly, apparently without motive;" they lose their power of attention, and finally tremble, stagger, and die. "When other animals—men, dogs, cats, poultry, crows, buzzards, and hogs, drink the milk or eat the flesh of a diseased cow, they suffer in a somewhat similar manner." This disease is attributed by Dr. Mitchell to the animals having grazed on pasture contaminated with mildew, and the resemblance to the effects of the amanita, together with the persistence of the specific principle within the fluids and tissues of the body, render it more than probable that to some fungoid growth, is due the peculiar toxic effects here noticed. Further: "The animals made sick by the beef of the first one, have been in their turn the cause of a like affection in others; so that three or four have thus fallen victims successively." De Graaf states, that butter made from {170} the milk of diseased cows, though heated until it caught fire, did not lose its deleterious properties. The urine of diseased animals, collected and reduced by evaporation, produced the characteristic symptoms. All these facts point to some peculiarity in the properties of matter not yet investigated or at least not explained. If we may assume that reproduction is here an element of the persistence and apparent multiplication of active matter, I know only of one instance to compare with it. A gentleman about to deliver a lecture on the properties of arsenic, and its history generally, made two solutions of a given quantity of arsenious acid, in the following manner. He took a certain amount of distilled water, and the same of filtered Thames water, and made his solutions of arsenic by separate boilings, he then as soon as possible placed the liquids in identical bottles, carefully prepared for their reception. In the one which contained the arsenic boiled in river water, the hygrocrocis is now growing, while that boiled in distilled water remains perfectly limpid and free from any vegetable production. There can scarcely be a doubt, that the filtration of river water was not sufficiently purifying to remove the minute spores of some lower forms of vegetation, which not only live in arsenic but have resisted the temperature employed in boiling an arsenical solution to saturation.

As to the first class, or truly reproductive and morbid poisons, the most heterogenous ideas have {171} from all time existed. I have introduced the notice of the above poisons, viz. the Amanita, and that which engenders the milk sickness, to compare the results of the morbid poisons on the human body with them, and also to associate them with the effects of diseased grain. From the Amanita and that other fungoid matter which is said to produce the milk sickness, there appears to be a purely toxic action on the system, but in the instance of diseased grain, a blood disease, ending in gangrene, or a specific and peculiar action of the generative organs is the consequence, and where the latter occurs, the poison usually expends itself on these parts, either by inducing abortion, or augmenting the catamenial secretion.

Now, the morbid poisons, if studied only in their results, shew that there is a combination of these two actions. There is usually, in the first place, a toxic or poisonous action, and secondly, a deteriorating or decomposing action on the blood, by which there is a tendency to low or asthenic inflammation and gangrene. It matters not what form of fever we take as an illustration, whether intermittent, pestilential, or exanthematous, either will serve the purpose of shewing how completely the effects of vegetable organic poisons resemble those which for the sake of distinction (I suppose) have been denominated Morbid Poisons.

Take an attack from the paludal poison. It is usually ushered in with head-ache, weariness, pains {172} in the limbs, and thirst, with other symptoms; all these are indicative of a poisonous agent in the blood: then come the full phenomena of the disease at a longer or shorter interval, and tending ultimately to destroy some organ of the body. The mind suffers during the course of the attack, and delirium occasionally happens. In severe cases of this disease, which were more frequent formerly than now, coma, delirium, and frenzy were observed at the commencement of the attack, and a tendency to rapid disorganization of one or several of the viscera.

If we take the effects of poison of Erysipelas, of Scarlet Fever, or Plague, in each we find at the onset more or less general derangement of the system, usually with cerebral disturbance and disordered action of all the dynamic forces of the body, which clearly indicate the action of a poison; then, unless some favourable symptoms arise, the blood exhibits a steady advance towards disorganization, and sphacelation of one or more tissues or parts of the body ensues. In Erysipelas the force of the diseased action is expended on the skin, and subcutaneous cellular tissue; in Scarlet Fever the fauces ulcerate, and slough and the parotids suppurate; in the Plague there is a general tendency to putrefaction, and the formation of glandular abscesses with sphacelas. Without going any further into this matter, for my present intention is merely to draw notice to certain facts, let me now ask, whether or not, do the poisons of the Ergot, the Uredo, {173} and the Amanita, exhibit more analogy in their action on the nervous system, the blood and the tissues, than any other poisonous agents with which we are acquainted? If the whole range of the lower fungi could be examined in reference to their operation on the blood, as decomposers of organic compounds,—if experiments could be made, by which the properties of fungoid matter could be detected, I would venture to say the whole of the phenomena of these diseases could be

readily comprehended and their intricacies unravelled.

We know that the fungi are poisonous, that at times and seasons, and under variations of climate, they vary in their effects, and perhaps lose altogether these properties. We know that the fungi produce gangrene of the tissues, and disorganization of the blood; we know that their spores pervade the atmosphere, and are ready, under favouring conditions, to increase and multiply; we know that they are ubiquitous, and that those conditions most favourable to their development, are exactly such as are proved to foster and engender disease, and above all, they have been proved to be the elements of some diseases in man, in animals, and in plants. Can as much be said of any other known agents, animate or inanimate, comprised in our category?

It has been said, we do not see after death,—the interlacing mycilium, or the sprouting pileus; {174}
therefore the fungi are not the agents of disease—it has been said that carbonic acid and alcohol are not found as products of diseased action—consequently disease is not a fermentative process. "In all cases," says Liebig, "where the strictest investigation has failed to demonstrate the presence of organic beings in the contagion of a miasm, or contagious disease, the hypothesis that such beings have cooperated, or do cooperate in the morbid process, must be rejected as totally void of foundation and support." Much as I admire the genius of this great man, it is difficult to refrain from remarking, that I doubt if any of his great discoveries would have been made, if, in the first instance, hypotheses had not formed the basis of all his researches. It has been said, "that casual conjunctions in chemistry, gave us most of our valuable discoveries:" and it is from casual conjunctions that hypotheses are usually formed, the working out proves either their fallacy or their truth, but to say that an hypothesis has no foundation, until demonstrated to be true, is rather knocking down argument. And who, let me ask, has been more prolific of hypotheses than our continental neighbour? Yet he, according to his mode of reasoning, would sweep away all such words from the vocabularies of philosophers. What foundation has the chemical hypothesis of disease, when it fails to explain the most important element of contagious {175}
and infectious diseases: viz. the reproductive property of their germs?

It is perhaps necessary to say something in explanation of the sudden deaths arising from morbid poisons. They may occur from two causes. One being the result of a concentrated amount of poison germs being inhaled into the lungs, and acting as an ordinary toxic agent; and the other, which I put only hypothetically, the consequence of the rapid evolution of gas in the vessels arising from a sudden decomposition of blood, as it passes through the lungs. The only authority I have for this supposition, is the fact that the blood after death, from pestilential affections, is found to be far advanced towards decomposition; that in Paris last year, two patients were bled while suffering from Cholera, and with the small quantity of blood which flowed, bubbles of air also escaped:[70] and besides this, it was demonstrated by Mr. Herapath, that ammonia was given off from Cholera patients, both by the lungs and skin. These facts, though they are not conclusive, nevertheless render it probable that such an explanation is not entirely out of reason —especially too, when we know how fatal are the effects of uncombined air, when it enters the vessels near to the heart.

SECTION III. {176}

WHAT RESULTS DO WE OBTAIN FROM THE EFFECTS OF REMEDIAL AGENTS, IN PROOF OF THE HYPOTHESIS?

I have here used the word hypothesis, because, having so far advanced in the enquiry, I trust sufficient has been said to render the term applicable.

Under the term remedial agents, I shall include all those causes, whether natural or artificial, which tend to neutralize or destroy the germs of infection, or miasmatic poison, whether this be effected out of or within the body.

First, then, let us consider the results of drainage and cultivation in removing the causes of endemic disease. One well authenticated case is as good as a thousand. I will take one, which, from its source, will be received as unexceptionable; and from its association with a very learned and amusing book, will be accepted as an agreeable reminder of the many pleasant hours spent in the perusal of the poet Southey's "Doctor."

"Doncaster is built upon a peninsula, or ridge of land, about a mile across, having a gentle slope from east to west, and bounded on the west by the river; this ridge is composed of three strata; to wit, of the alluvial soil deposited by the river in former ages, and of limestone on the north and {177}
west; and of sandstone to the south and east. To the south of this neck of land, lies a tract called Potteric Carr, which is much below the level of the river, and was a morass, or range of fens when our Doctor first took up his abode in Doncaster. This tract extends about four miles in length, and nearly three in breadth, and the security which it afforded against an attack on that side, while the river protected the peninsula by its semicircular bend on the other, was evidently one reason why the Romans fixed upon the site of Doncaster for a station. In Brockett's Glossary of North Country words, Carr is interpreted to mean 'flat marshy land,' 'a pool or lake;' but the etymology of the word is yet to be discovered.

"These fens were drained and enclosed pursuant to an Act of Parliament, which was obtained for that purpose in the year 1766. Three principal drains were then cut, fourteen feet wide, and about four miles long, into which the water was conducted from every part of the Carr southward, to the little river Torne, at Rossington Bridge, whence it flows into the Trent. Before these drainings, the ground was liable to frequent inundations; and about the centre there was a

decoy for wild ducks; there is still a deep water there of considerable extent, in which very large pike and eels are found. The soil, which was so boggy at first that horses were lost in attempting to drink at the drains, has been brought into good cultivation, (as all such ground may be) to the {178} great improvement of the district; for till this improvement was effected, *intermittent fevers and sore throats were prevalent there, and they have ceased from the time the land was drained*. The most unhealthy season now, is the spring, when cold winds, from the north and north-east, usually prevail during some six weeks; at other times Doncaster is considered to be a healthy place. It has been observed that when endemic(?) diseases arrive there, they uniformly come from the south; and that the state of the weather may be foretold from a knowledge of what it has been at a given time in London, making an allowance of about three days, for the chance of winds. Here, as in all places which lie upon a great and frequented road, the transmission of disease has been greatly facilitated by the increase of travelling."

I feel certain of being excused for transcribing this long passage from Southey. It would have been impossible to convey its whole meaning without giving it entire. The continuation of the chapter is no less instructive and applicable to our subject, though more particularly so to an extension of the enquiry. The sore throats and intermittents, from which Doncaster has been freed, by the drainage of Potteric Carr, informs us at once that decomposing matter is the material by which the poison of fever is vivified and sustained, the wet and boggy state of the soil is just the condition, when no drainage exists, to bring into activity the germs of disease, which {179} otherwise would lie latent. So satisfied and acquainted are we with the elements necessary for the production of fever, that we might as certainly bring about an endemic intermittent by forming an artificial bog, as we could be sure of growing mushrooms by making a bed in the manner laid down by gardeners for this purpose. Dr. Lindley also says, "the *Polyporus fomentarius* has been artificially produced in Germany, but merely by placing wood in a favourable situation, and keeping it well moistened. Five or six crops were obtained in the year."

Let warmth, moisture, darkness, and decaying matter be given, and inanimate disintegrated particles will soon be converted into definite forms and combinations instinct with life. It is by the unseen forms of living beings, that the atmosphere is preserved from becoming charged with deadly gases; they take the first rank in the great scheme of animated beings, the plant first, and then the animal. "Let the earth bring forth grass." "Let there be lights in the firmament." "Let the waters bring forth the moving creature, and fowl that may fly," and "Let the earth bring forth the cattle, the creeping thing, and the beast." This is the order of creation, of living things, and the earth was prepared by vegetation for the animal world. The work of conversion is accomplished by vegetation; and this is consumed for the construction of higher organizations.

The laws which govern and control the universe, are as definite and as wonderful among invisible {180} atoms, as those which regulate the enormous masses floating in space; and the time will come when the advancing intellect of man will measure and weigh the morbid poisons, as he measures and weighs the stars. Why should the laws of Epidemics be less understood, than the laws which govern the course of comets? The aspirations of man have led him to penetrate the heavens, which charm and inspire him; he studies rather the more violent disturbing elements of nature, the thunder-cloud and the fire of heaven, than the silent pestilence which steals over the earth. I cannot conceive it possible that the Intellects, which are occupied in procuring means for the Majesty of this empire to issue her mandates with the velocity of a spirit to the nethermost parts of the earth, should be incapable of solving so deeply interesting a mystery as the causes and nature of pestilential diseases. It would seem that man prefers to issue a mandate of destruction many thousand miles distant, than to disarm the pestilence at his door. It is barely a century since Galvani observed the twitchings in the muscles of a frog's leg, and the battery, still named after him, has already become an agent of instantaneous communication between places many miles distant. But how many centuries have passed away, each one succeeding the other, with its millions of victims to epidemics? And where are the remedies for the evils? Drainage and cleanliness, with all their advantages, were better understood and more fully carried out by the ancient Romans than by ourselves; there are monuments, though crumbling to decay, to tell us of {181} the vast enterprise of these people and of the value they set upon a healthy and vigorous constitution, and how well they understood the means of warding of disease.

Cultivation and drainage are now fully understood to be the basis by which a healthy condition of air is to be obtained, next to that, cleanliness and ventilation; if either be neglected a sickly, mouldy, and unwholesome contamination of atmosphere ensues; the odour of a bog is proverbially mouldy, and so is that of an ill-ventilated house or cellar; dryness, or the fresh pleasant scent of clean water, are the antagonists of these; the aromatic odours of vegetation are opponents of putrefaction, and consequently of the development of the lower forms of life. All empyreumatic matters prevent mouldiness and decomposition; and odours arrest and prevent the growth of mouldiness. The oil of birch, with which the Russia leather is impregnated, and which gives it so pleasant an odour, effectually prevents mouldiness, and consequently decay.

Lindley says, "It is a most remarkable circumstance, and one which *deserves particular enquiry*, that the growth of the *minute fungi*, which constitute what is called mouldiness, is *effectually prevented* by any kind of perfume."[71] Cedar has been used, from time immemorial, for a like {182} purpose; and I doubt not the recommendation of Virgil, before quoted, in reference to the burning of cedar, was founded on some practical utility of this kind, though its *modus operandi* was unknown to him. Allied to these is a curious circumstance, and worthy attention. I copy the following from an old work on Pestilences. "It is remarkable that when the Plague raged in London, Bucklersbury, which stood in the very heart of the city, was free from that distemper;

the reason given for it is, that it was chiefly inhabited by druggists and apothecaries, the scent of whose drugs kept away the infection, which were so unnatural to the pestilential insects, that they were killed or driven away by the strong smell of some sorts of them." "The smell of *rue*, and the smoke of tobacco, were prescribed as remedies against the infection; but especially tar and pitch barrels, which it was imagined preserved Limehouse, and some of the dock-yards from infection."[72]

Pitch and tar dealers are everywhere spoken of as being remarkably exempt from infectious diseases.

Cold infusion of tar was used in our colonies as a prophylactic against the Small Pox. Bishop Berkeley was induced to try it when this disease raged in his neighbourhood. The trial fully answered expectation—for all those who took tar-water, either escaped the disease, or had it very slightly. {183}

Tan yards and places in the immediate vicinity, are said to be free from pestilences. The tanners of Bermondsey are said to have escaped the Plague of London, and one person only died in Gutter Lane, where was a tan yard. The tanners of Rome are also stated to have been free from Plague. Dr. M'Lean refers to the exemption of tanners at Cairo. *Tannin is prejudicial to most vegetables*,—but Dr. Lindley says it is not always so to fungi. "A species of Rhizomorpha is often developed in tan pits." I should imagine that neither plants nor insects would be found very abundantly, where tannin prevails; yet we find that the gall-nut is formed for the protection of an insect from injury by weather, and as a temporary means of sustenance.

The custom of fumigating with odoriferous substances, does not therefore appear upon this view of the matter to be destitute of importance; indeed, the universal practice stamps it at once, as an efficacious remedy for the purposes of disinfection. The introduction of chlorine fumigation, seems to have superseded, in a great measure, the use of fragrant herbs and woods; and it is questionable whether the substitution be altogether desirable or advantageous. Many scents may be agreeably and usefully employed, with much less chance of annoyance to the patient, and considerably less injury to articles of furniture, &c. {184}

The fumigations of sulphurous acid and chlorine are, perhaps, more adapted as disinfectants in uninhabited apartments;—their power to destroy vegetation, is well known. They have been used, chiefly, with the idea of neutralizing gaseous exhalations, particularly chlorine, as it tends to combine with hydrogen, to form hydrochloric acid, and then to unite with ammoniacal matters, forming hydrochlorate of ammonia. This, supposing noxious or pestilential effluvia consisted of the ammoniacal exudations variously combined, was an exceedingly efficacious method of rendering them inert; but as we feel convinced that no ammoniacal compound could possibly be the cause of infection, we must look to the influence these gases possess over other forms of matter, and as they are so destructive, even in minute quantities, to vegetable existence, it is possible that their beneficial effects may be due to this property. The immediate neighbourhood of gas works is prejudicial to vegetation, I imagine, from the amount of sulphurous vapours, and to this has been attributed the exemption of persons employed in these works. Many other instances might be cited of a similar nature.

I have now to speak of medicinal agents, and here comes a considerable difficulty. {185}

If we might believe all that has been written on the sure and certain remedies for the "ills that man is heir to," we should be led to acknowledge that both nature and art were prodigal in antidotes and specifics. The all-bountiful hand of nature, I do not doubt, has at the same time scattered the seeds of good and of evil. The fertilizing showers fall to irrigate the soil, and produce food and nourishment to man; here and there is the reeking morass "feeding unnatural vegetation," and if man takes up his abode in its vicinity, the rains which made it unhealthy, have also made it highly fertile; by labour and cultivation he may convert the mephitic bog into a waving corn-field, and the seeds of life and sustenance be made to supplant the seeds of death and corruption.

It is generally believed, that where there are particular and specific diseases, there also may be found appropriate and specific remedies; the discoveries of chemistry, it is not improbable, may in some respects have retarded the progress of natural medicine. In the early ages of the world, the "healing plant" must have formed the staple of medical commerce, for though Tubal Cain[73] has been considered as the first surgical instrument maker, because he was the first artificer in brass and iron, we have not discovered that chemical compounds entered into the composition of physic, till very many years after his time. To the alchemists we owe the science of chemistry, and much of the physic of the present day may be traced to them. The multiplicity of ingredients which at one time entered into the composition of one dose of physic could only be spoken of under the title of "legion." Who shall specify the active and curative ingredient (if there be one), when from five to a hundred may have been exhibited at the same time? It has been the pride of our physicians, that the pharmacopœia has been simplified; it has not reached its most simple form yet. That many simple plants have specific and wonderful power over disease, is an indubitable fact, but I firmly believe that the laudable, though mistaken efforts of physicians to improve their effect by various combinations, have been the means of throwing many valuable medicines into oblivion; I must also add, that cheap physic and adulterations have had no small share too in the banishment of much valuable physic from ordinary practice. It has been believed, and I think with much reason, that a thorough search into the qualities of plants, would shew that "they are capable of affording not only great relief, but also effectual and specific remedies." {186}

"That they are not already found, is rather an argument that we have not been sufficiently inquisitive, than that there are no such plants endued with these virtues."

Of the result obtained by medical treatment, in cases of epidemic or infectious disease, it is most difficult to speak, but as my province here is only to shew that living germs are the morbific {187} agents, I have but to refer to such remedies as have been most extolled in controlling these affections. The disinfectants have already been mentioned in a cursory manner. An enumeration only of simple medicines used during the late Epidemic, shall conclude this work, as the treatment in former times could not by any possibility furnish satisfactory information. Aromatics and fragrant stimulants have in all times taken the foremost rank with acids, such as vinegar, lime and lemon juice. Mr. Guthrie's adoption of lemon juice in preference to bark, which he said made him worse while suffering from an attack of fever, during the Peninsular campaign, and his speedy recovery from the disease, though not from its effects, shews, when many others can bear equal testimony to its value, that such a remedy though simple is not to be despised.

But to the late Epidemic. Dr. Stevens' saline treatment, appears, on the whole, to have been the most successful. Common salt was used both medically and dietetically, and formed the greatest bulk of the medicine employed. Chlorate of potash and carbonate of soda were added to the medicine.

The nitro-hydrochloric acid was used with success at St. Thomas's Hospital.

Dr. Copland used chlorate of potash, bicarb. soda, hydrochloric, ether, and camphor water.

Dr. Ayre's calomel treatment had as many, if not more, opponents than advocates. Phosphorus {188} had several advocates.

Creasote and camphor were lauded by some. The beneficial operation of all these remedies might be explained on the theory here supposed, that living germs are the cause of Epidemic disease, but the specific action of any one remedy has not yet had sufficient attention or trial to enable me to make any deductions of a satisfactory or conclusive nature.

In the uncertainty which generally prevailed as to the best method of treating Cholera patients, I was induced (for reasons stated in a pamphlet published last year) to try the efficacy of sulphur, which had been extolled as a specific. In its effects I was not disappointed; but as the results are already before the public, I need not do more than refer to it among other remedies.

I did not contemplate even alluding to this subject, as it would extend far beyond my intended limits. This portion of the enquiry would be more properly carried out by keeping records of cases, treated in accordance with the view attempted to be established, and I have not the slightest hesitation in saying, that the most ample success would ultimately attend a well directed practice, based upon the principles inculcated in these pages.

CONCLUSION. {189}

In making the foregoing sketch, I have attempted to put together some ideas on a subject, which has for the last few years been a theme for meditation in leisure hours, viz. What are the causes of Epidemic, Endemic, and Infectious Diseases? The occurrence of Epidemic Cholera last year in this country, awakened a spirit of enquiry. Where there is unrest, whatever may be the cause, there also is disquiet and discontent. When the oracles of the age were consulted in the emergency, the discordant answers perplexed and confused the anxious searcher after truth. In the spring of last year, when the enemy was approaching, unseen and unheard, and the thousands of unconscious victims, who are now lying in their graves, were faithfully trusting and fully relying on the heads of our profession, and the resources of our art, what was the state of our defences, and what the nature or character of our resistance? One considerable body of men would discharge from a little tube of glass, a host of almost invisible globular atoms of sugar, said to be as potent and inscrutably operative as the unseen enemy. These infinitesimal practitioners assured the people that they "*had powerful means of subduing the disease*," but even they {190} differed among themselves, though they carried out to the fullest extent the doctrine of their leader, *similia similibus*, which we may suppose to refer in this case to the minuteness of the opposing armamenta. Without, however, agreeing with this school, I may quote a passage from Dr. Curie, which is, alas! too true: "We have shewn, as they must (allopathists), and many of them do acknowledge, that they have no fixed basis, no natural law upon which their treatment rests."

Who can deny the force of this observation? Sheltered by a principle, it matters not how fallacious, a man is placed as behind a barrier. If with any reason it could be shewn that the infinitesimal doses, could by no possibility effect a cure in Cholera; if it could be demonstrated by any line of argument, that a poison, a living poison, circulates with the blood, or lodges in the tissues, the homæopathist must fall; his "electricity and mineral magnetism," and "*powerful concentration of life power towards the digestive canal*," will stand for what they are worth. That minute doses of medicine can exert an active influence over the body is not to be denied, but these must consist of powerful drugs, as arnica, aconite, and nux vomica, with others, and it is more than probable, that of such medicines, an inconceivably small amount may produce a specific effect upon some portion of the organic nervous system.

How is it that a dose of nitre or digitalis, "can convert cheerfulness into low spirits," or a grain of {191} red sulphuret of antimony, "excite warmth and lively spirits?"[74]

Why should indigo dyers become melancholy, and scarlet dyers choleric?[75] We do not know. But there is one thing we most certainly do know, that a poison may be disarmed by an antidote, and the amount of the latter must be in proportion to that of the former, and as epidemic and contagious diseases do most unquestionably depend upon poisons of a specific nature, and of great amount and activity, an infinitesimal remedy, however it may claim to direct and control the organic forces, under slight and ordinary disturbances, can be no more effectual in destroying the poison of fever, or small pox, than in neutralizing arsenic or prussic acid.

The uncertainty which generally prevails as to the treatment of Epidemic diseases, Fevers, &c. induced me to put together the notions which are contained in these pages, in the hope of leading to some definite ideas of the causes of these affections, and consequently to a more uniform and scientific mode of treating them.

I have endeavoured to shew that reproduction is a phenomenon inseparable from morbific matter, and that in all probability the vegetable kingdom is the source of the germs.

The train of argument adopted is such as appeared to me most natural for such an enquiry, and it {192}
rests now only with those who are capable of deciding whether such a course, though (I am sensibly aware) not without many faults in conception and execution, is calculated to advance the science of medicine and the interests of mankind.

The real tree of knowledge, possesses in the spongioles of its roots, an elective property, by which truth alone can enter; nourished and sustained by this, it sends a fragrant incense and breathing odour on high, and dispels the mists of ignorance and superstition. In natural causes and reasonable deductions we must seek for instruction and solid information, for in over-straining either nature or art, deformity and error must inevitably be the result.

THE END.

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NOTES

[1] "It matters little how vague and false hypotheses may appear at first: experiment will gradually reduce and correct them, and all that is required, is industry to elaborate the proof, and impartiality to secure it from distortion."—*Sewell* "On the Cultivation of the Intellect."

[2] It is stated by Mr. Crosse, of Norwich, that vaccination was adopted in Denmark, and made compulsory in 1800. After the year 1808 Small Pox no longer existed there, and was a thing totally unknown; whereas during the twelve years preceding the introduction of the preventive disease, 5,500 persons died of the Small Pox in Copenhagen alone.—*Dr. Watson's Lectures.*

Dr. Blick, an intelligent Danish physician, corroborated the above statement to Dr. Watson himself in the year 1838.

[3] Philosophy of Life, Lecture 6, translated by the Rev. A. J. W. Morrison, M.A.

[4] The following I quote from Dr. Fuller on Small Pox and Measles:—

"To this purpose some (and particularly Kircherus) are of opinion that animalcules have been the causes of malignant and pestilential fevers in epidemic times, which differ in essence and symptoms, according to the nature and venoms of those creatures.

"Thus the atmosphere and air is filled both from above and beneath with innumerable millions of millions of species or corpuscles, aporrhœas, steams, vapours, fumes, dust, little insects, &c. all which make it such a wonderful chaotic compost of things that contains the *seeds* of good and evil to man as surpasseth the understanding (as I suppose) of even the highest order of archangels."

[5] I learn from an undoubted authority that the cow when "slack of health" eats with avidity the "field parsley;" the sheep under similar circumstances seeks the ivy, and the goat the plantain.

From an equally good source I have the following: that rabbits and hares, when they are what is commonly called *pot-gutted*, seek the green broom, though at a distance of *twenty miles*.

[6] "My settled opinion is, that in regard every effect is necessarily such as its cause; it must needs be that every sort of venomous fevers is produced by its proper and peculiar species of virus.

"And that the manner and symptoms of every such fever is not so much from the particular constitution of the sick; as from the different nature and genius of their specific venom which caused them.

"And I conceive that venomous febrile matters differ not in degree of intenseness only, but in essence and *toto genere* also; and that venomous fevers are for the most part

contagious."—*Thomas Fuller, M. D. 1730.* "Another important class of organic poisons are those which when introduced in almost inappreciable quantities into the system, seem to increase in quantity; and which when communicated in the same inappreciable quantity from the individual poisoned to one who is healthy, excite the same series of febrile phenomena and local inflammation, and the same increase in the quantity of the poisonous agent."—*Med. Chir. Review.*

"This unseen influence working in the body, presents very striking analogies to the modes of operation of different poisons."—*Dr. Ormerod on Continued Fever.*

[7] I am aware that the vesicle does not here strictly bear the relation to the original germ, supposing one active particle alone to be sufficient for its production, that the egg does to the bird, for in the former case multitudes of active particles may have been generated from one. I have, therefore, merely used this expression to signify an aggregation of vital forces, such as may be imagined to exist in the bird.

[8] "At an early period the form of the ovisacs is usually elliptical, and their size extremely minute,—their long diameter measuring in the ox no more than 1/562 of an inch, so that a cubic inch would contain nearly two hundred millions of them. They are *at this time* quite distinct from the *stroma* of the ovarium; this forms a cavity in which they are loosely embedded."

[9] Coleridge, p. 56.

[10] "All vegetables," says Sharon Turner, "from that pettiness which escapes our natural sight, to that magnitude which we feel to be gigantic, have these properties in common with all animals—organization; an interior power of progressive growth, a principle of life, with many phenomena that resemble irritability, excitability, and susceptibility, and a self-reproductive and multiplying faculty."—*Sharon Turner's Sacred History.*

[11] "Plants highly sensitive to light are those of the leguminous, or Pea kind. They always close up in the evening and clasp their two upper surfaces together, presenting only their backs to the air. Plants of pinnated leaves, as the Tansy, are more sensible than these to the effects of light. They fold up when light is too strong, as in Robinia; it produces the same effect as want of light. Its leaves close up, apparently, because they are receiving too much. So they do if a hot iron be brought near them. They contract as if to avoid the heat. Sensitive plants, and those of the Oxalis Lent. are so sensitive that the least motion, even a breath of air, will make them close."—*Sir J. Smith.*

"The vitality of plants seems to depend upon the existence of an irritability, which although far inferior to that of animals, is nevertheless of an analogous character."—*Lindley's Introduction to Botany.*

[12] Provincial Medical and Surgical Journal. July 10th, 1850. No. xiv. p. 367. "Practical Observations on the Vaccination Question." By E. Oke Spooner, M. R. C. S., Blandford.

"If we examine the Cow Pox and the Small Pox microscopically, as I have done very carefully in every stage, we find that the essential character consists of a number of minute cells, not exceeding the 10,000th part of an inch in diameter, being about one-fourth smaller than the globules of the blood, containing *within their circumference many still more minute nuclei, and presenting* beyond their circumference bud-like cells of the same size and character as those contained within the circle. They exactly resemble in everything except the size, the globules of the yeast plant, the Torula Cerevesiæ. Now if we examine more circumstantially the analogies of what I would call the Torula Variolæ with the Torula Cerevesiæ, we observe the following corresponding facts.

"What do we accomplish by inoculation as it is called? Simply this. We take on the top of a lancet, or an ivory point, a few of these minute cells or germs, and we put them *in their appropriate nidus*, the subcuticular tissue, where, after a few days if they find their appropriate nutrient elements, they grow and multiply."

Simon, Chemistry of Man, vol. i. p. 127. "Macgregor ascertained that the air expired by persons ill of confluent Small Pox, contained as much as *eight* per cent of carbonic acid, and in proportion as health was restored the percentage was diminished to its natural standard." Carbonic acid is also produced during the process of fermentation and germination.

[13] See History of the Jews, p. 71.

[14] It is said by Whewell, that the murrain is supposed to have fallen only on the animals which were in the open pasture.—*History of the Jews.*

"J. S. Michael Leger, published at Vienna, in 1775, a treatise concerning the mildew as the principal cause of the epidemic disease among cattle. The mildew is that which *burns* and *dries* the grass and leaves. It is observed early in the morning, particularly after *thunder-storms*. Its poisonous quality, which does not last above twenty-four hours, never operates but when it is swallowed immediately after its falling."—*Mitchell on Fevers.*

[15] "The prevalence of the south-east wind was observed to be particularly favourable to the increase of both cholera and influenza: and I cannot but think that this had some

connexion with the general tendency exhibited by the former to spread from east to west. Has the morbific property of this wind aught to do with the haziness of the air when it prevails—a haziness seen in the country remote from smoke, and quite distinct from fog? What is this haze? In the west of England a hazy day in spring is called a *blight*."—*Dr. Williams' Principles of Medicine.*

[16] We are to understand also that some peculiar operation took place of a nature difficult to comprehend, which seems also to typify reproduction, for the handfuls of ashes which Moses threw into the air *became a dust in all the land of Egypt*, thus signifying an enormous reproduction of atomic matter.

[17] The Chinese affect to trace the origin of Small Pox back to a period of at least 3000 years, or 20 years beyond the era of the Trojan war, 1212, A. C.

The Chinese pretend to discriminate no less than 40 different species of Small Pox.

"They also pretend to discover whether a person has died by violence or from natural causes, not only after the body has been some time interred and decomposition of the softer parts has commenced, but even after the total disappearance of the soft parts, and when the dry skeleton alone is left."—For the process, see *Hamilton's History of Medicine*, vol. i. p. 31.

To give some notion of the state of Medical Science among the Chinese, I may quote the following: "The theory of the circulation of the blood, Du Halde affirms, was known by the Chinese about 400 years after the deluge; be this assertion veracious or not, no correct knowledge up to the present day, do the nation possess of the circulating system of the human frame."—*China and the Chinese, Henry Charles Sirr, M. A.*

According to their anatomy, the trachea extends from the larynx through the lungs to the heart, whilst the œsophagus goes over them to the stomach.

[18] "And Aaron took as Moses commanded, and ran into the midst of the congregation: and behold the plague was begun among the people; and he put on incense and made an atonement for the people. And he stood between the dead and the living, and the plague was stayed."—*Numbers.*

The practice of burning scented herbs has been observed in all times during an invasion of the plague, as a means of protection. Also wearing perfumes and aromatic preparations has been recommended. Whether they have any counteracting influence, it is impossible to say.

Virgil in the third Georgic speaks of a murrain among cattle. He says, if any wore a vestment made of wool from an infected sheep, fiery blains and filthy sweat overspread his body, and ere long a pestilential fire preyed upon his infected limbs.

In his directions for preserving the health of flocks he says—

> "Disce et odoratam stabulis accendere cedrum."

The motive for burning the fragrant cedar is not mentioned; we cannot doubt but it was a good one, and having some great practical utility, from the following line—

> "Galbaneoque agitare graves nidore chelydros."

[19] The earliest mention of this complaint upon which reliance can be placed, is an ancient Arabic MS. preserved in the public library at Leyden. "This year, in fine, the Small Pox and Measles made their first appearance in Arabia." The year alluded to being that of the birth of Mahomet, or the year 572 of the Christian æra.—*Hamilton's History of Medicine*, vol. i. p. 215.

[20] Dr. W. A. Greenhill's translation.

[21] The Black Assize at Oxford, 1572, is an instance in which a pestilential vapour suddenly appeared in the court, "whereby the judge, several noblemen, and more than 300 others, died within three days."

"Of an unaccountable vapour suddenly coming, I have this relation from Richard Humphrey, my neighbour, and a man of veracity, that on Wednesday, April 27, 1727, as he and one Walter, were travelling a-foot from Canterbury; when they came to Rainham, they were assaulted with such a strong loathsome stink, as he thought was like the stench from a corrupted human corpse. They were so offended at it, as thinking it was from carrion in that town, that they would not stay there to rest and refresh themselves, but travelled on for about two hours, mostly in the stench, but sometimes out of it, till they came to the hill that leads down to Chatham: and there they went clear out of it and smelt it no more."—*Dr. Fuller*.

It appears that these persons did not fall sick of any disease, but the fact of itself is remarkable enough.

[22] Hamilton's History of Medicine.

[23] It has been said, that "an induction once carefully drawn, is as perfect from a single instance as it is from ten thousand, and that it is only an uncultivated mind which requires a load and accumulation of knowledge to assist his thoughts."—*Sewell* "on the Cultivation of the Intellect."

[24] See Dr. Alison's Pamphlet on the Fever in Edinburgh.

[25] Earthquakes have in all times been considered to have some connexion with pestilences. "A most grievous pestilence broke out in Seleucia, which from thence to Parthia, Greece, and Italy, spread itself through a great part of the world, from the opening of an ancient vault in the temple of Apollo, and that it raged with so much fury as to sweep away a third part of the inhabitants of those countries it visited."—*Dr. Quincy, on the Causes of Pestilential Disease.*

"Upon an earthquake the earth sends forth noisome vapours which infect the air; so it was observed to be at Hull in Yorkshire, by the Rev. Mr. Banks, of that place, after a small earthquake there in 1703, it was a most sickly time for a considerable while afterwards, and the greatest mortality that had been known for fifteen years."—*Anonymous*, 1769.

[26] See Sharon Turner's Sacred History, text and notes, vol. i. p. 161 & 162.

[27] "Each seed includes a plant; that plant, again,
Has other seeds, which other plants contain,
Those other plants have all their seeds; and those
More plants, again, successively enclose.
Thus ev'ry single berry that we find,
Has really in itself whole forests of its kind.
Empire and wealth one acorn may dispense,
By fleets to sail a thousand ages hence;
Each myrtle-seed includes a thousand groves,
Where future bards may warble forth their loves."

[28] "On June 5th, 1849, a man and his son, a lad aged 14 years, left Noss to fish, and when five miles out at sea, no vessel being in sight, they both simultaneously became aware of a hot *offensive* stream of air passing over them. It was so decided, that the crab pots were examined to discover if it were from them, but it did not, and five minutes after the father's attention was directed to the boy, who was vomiting and purging."—*Dr. Roe on the Cholera at Plymouth, Med. Gaz. Aug. 24th, 1850.*

[29] Linnæus remarked that Erigeron Canadense was introduced into gardens near Paris from North America. The seeds had been carried by the wind, and this plant was in the course of a century spread over all France, Italy, Sicily and Belgium.

[30] Hecker.

[31] This is found most generally to be the case where rivers flow through uncultivated tracts of country. The Californian emigrants suffer much from diarrhœa and dysentery, if they drink of the river and certain well waters of that gold district.

[32] "Purification from leprosy. As this fearful disease was contagious and hereditary to the third and fourth generation, the separation of lepers from the camp and congregation, and the destruction of infected houses and clothes, was of the utmost importance to the preservation of public health.

"Leprosy was of three kinds: 1st, Leprosy in man. 2nd, Leprosy in houses. 3rd, Leprosy in clothes.

"Contagious or malignant leprosy was of two kinds, viz.

"1st. The white leprosy, or bright berat, which was the most serious and obstinate form which leprosy assumes. It exhibited itself as a bright white and spreading scale, on an elevated base; turning the hair white in patches, which were continually spreading.

"2nd. The black leprosy, or dusky berat, which was less serious than the foregoing. It did not change the colour of the hair, nor was there any depression in the dusky spot; but the patches were perpetually spreading, as in the white leprosy."—*Analysis and Summary of Old Testament History. Oxford.*

[33] The Mexican Aloe blows when nine years old, and then dies. At least this is its usual course in the island of Cuba.

[34] "Ground that has not been disturbed for some hundred years, on being ploughed, has frequently surprised the cultivator by the appearance of plants which he never sowed, and often which were then unknown to the country. The principle has been ascertained to be capable of existing in this latent state for above 2000 years, unextinguished, and springing again into active vegetation, as soon as planted in a congenial soil.

"In boring for water near Kingston on Thames, some earth was brought up from a depth of 360 feet, and though carefully covered with a hand-glass to prevent the possibility of

other seeds being deposited on it, was yet in a short time covered with vegetation.

"Turner says, from the depth, these seeds must have been of the diluvian age."—*Jesse's Gleanings.*

[35] Hamilton's History of Medicine, vol. ii. p. 276, note.

[36] "What I wish you to remark is this, that while almost all men are prone to take the disorder, large portions of the world have remained for centuries entirely exempt from it, until at length it was imported, and that then it infallibly diffused and established itself in those parts."—*Dr. Watson on the Principles and Practice of Physic.*

Dr. R. Williams says, "The seeds of intermittent fever lay dormant for months, it was not at all uncommon for cases of intermittent fever to be brought into the hospital eight or ten months after the patients had subjected themselves to the influence of paludal or marsh effluvia."

[37] I have observed in the hot-houses, that many of the exotic plants, which are in company with the diseased vines, have been attacked, while others again have been entirely free.

[38] By causes of the greatest variety plants may become extinct for a time. It is not very easy to trace them, but one fact may be mentioned in proof of the statement. Dr. Prichard states that vast forests are destroyed either for the purpose of tillage or accidentally by conflagrations. "The same trees do not reappear in the same spots, but they have successors, which seem regularly to take their place. Thus the pine forests of North America when burnt, afford room to forests of oak trees."

[39] Hecker says of Chalin de Vinario, that "he asserted boldly and with truth, that *all epidemic diseases might become contagious, and all fevers epidemic,*—which attentive observers of all subsequent ages have confirmed." P. 60.

[40] In 1539, the thirty-first year of Henry the Eighth, was great death of burning agues and flixes; and such a drought that welles and small rivers were dryed up, and many cattle dyed for lacke of water; the salt water flowed above London Bridge.—*Stowe.*

In 1556, the fourth of Mary, and the third of Philip, about this time began the burning fevers, quarterne agues, and other strange diseases, whereof died many.—*Stowe.*

The next winter, 1557, the quarterne agues continued in like manner, or more vehemently than they had done the last yere.—*Stowe.*

[41] Every writer on the climate of Egypt has remarked, that the Endemic Fever which is so frequent, originating on the coast, particularly about Alexandria, becomes occasionally so virulent, that it cannot be distinguished from the *true Plague.—Robertson on the Atmosphere*, vol. 2. p. 384.

"Endemial Fevers of every situation become occasionally so aggravated, that they cannot be distinguished from such as originate from contagion; and in every unusual virulence of this Endemic Fever, it is probable that it may be propagated afterwards by contagion as every epidemic." *Ibid.* p. 388.

[42] Dr. Ure.

[43] "The metamorphosis of starch into sugar depends simply, as is proved by analysis, on the addition of the elements of water. All the carbon of the starch is found in the sugar; none of its elements have been separated, and except the elements of water, no foreign element has been added to it in this transformation."—*Liebig*, *Organic Chemistry*, p. 71.

[44] As regards starch there appears to be some peculiar faculty regarding it. It is converted into sugar during the ripening of fruit, and it is just possible that being as it is of a cellular nature, the property of vitality may attach to it until it has, by being converted into sugar, fulfilled its destination.

[45] Though I do not consider that the fermentation process is a fac-simile of diseased action, yet I think its phenomena generally afford an apt illustration of the changes which may be effected by living germs. Many able chemists still maintain the entire dependence of fermentation upon the Torula: "M. Blondeau propounds the view that *every kind* of fermentation is *caused* by the development of fungi."

The varieties of opinions found in the literature of this subject, forms a curious specimen of scientific enquiry, and is sufficient alone to convince us of its vast importance and extensive relations.

[46] By Dr. Mantell.

[47] Mitchell on Fevers.

[48] We wonder, and ask ourselves: "What does SMALL mean in Nature?"—*Schleiden's Lectures on Botany.*

[49] Speaking of the bunt in wheat: "It appears certainly to be contagious, from numerous

experiments, which shew that the contagious principle lasts a long time. I have tried it myself; some, however, doubt it, but it cannot be denied, that seed sown, infected with bunt, produces plants similarly affected; every one who has had the slightest experience must be convinced of it."—*Essay on the Diseases of Plants. Count Ré.*

[50] We have already spoken of the effects of these poisons, and have stated that the amount of each poison capable of destroying the body is pretty accurately known.

[51] The italics are my own.

[52] Gmelin says: "But the mode of action in these transformations, sometimes admits of other explanations; and when this is not the case, our conception of it is by no means sufficiently clear to justify the positive assumption of this, so called contact-action or catalytic force, which, after all, merely states the fact without explaining it"—*Gmelin's Hand-book of Chemistry*, vol. i. p. 115.

[53] The history and symptoms of some epidemic diseases, such as cholera and influenza, are not inconsistent with the hypothesis that they are caused by the sudden development of animalcules from ova in the blood. But there is a total want of direct observation in support of this hypothesis.—*Dr. Williams' Principles of Medicine.*

[54] Since writing the above, I have referred for information on this subject, and find, that the Anguillula aceti exhibits sexual distinctions; and that the ovaries of the females are situated on each side of the alimentary canal.—*Cyclo. Anat. and Phys. Art. Entozoa.*

[55] Speaking of the examination of the infusory animalcules—Mr. Kirby says: "But to us the wondrous spectacle is seen, and known only in part; for those that still escape all our methods of assisting sight, and remain members of the invisible world, may probably *far exceed those that we know*."—*Bridgewater Treatise*, vol. i. p. 158.

[56] Mr. Owen has added another class, as the first, called Protelmintha, which comprises the cercariadæ and vibrionidæ.

[57] "It is probable that in the waters of our globe an infinity of animal and vegetable molecules are suspended, that are too minute to form the food of even the lowest and minute animals of the visible creation: and therefore an infinite host of invisibles was necessary to remove them as nuisances."—*Bridgewater Treatise*, vol. i. p. 159.

"When Creative Wisdom covered the earth with plants, and peopled it with animals, He laid the foundations of the vegetable and animal kingdoms with such as were most easily convertible into nutriment for the tribes immediately above them. The first plants, and the first animals, are scarcely more than animated molecules,* and appear analogues of each other; and those above them in each kingdom represent jointed fibrils."† —*Bridgewater Treatise*, vol. i. p. 162.

* Globulina and Monus. † Oscillatoria and Vibrio.

[58] "A treatise which should present a systematic arrangement of all the diseases of plants, giving in detail the exact history of each, and adding the means of preventing and curing them, would certainly be of the greatest utility to agriculture." —*Essay on the Diseases of Plants, Count Philippo Ré, translated into Gardener's Chron.*

[59] "Plenck published a treatise on Vegetable Pathology, in which he divided diseases into eight classes: 1. External injuries; 2. Flux of juices; 3. Debility; 4. Cachexies; 5. Putrefactions; 6. Excrescences; 7. Monstrosities; and 8. Sterility. And he concludes with an enumeration of the animals which injure plants."—*Essay on the Diseases of Plants, Gardener's Chronicle.*

[60] The Bunt. "This disease appears at the moment of the germination of the plant. The affected individuals are of a dark green, and the stem is discoloured. As the ears are issuing from the sheaths, their stalks are of a dark green, but very slender. When the ear has fully grown out, its dull, dirty colour, causes it to be immediately distinguished from the healthy ones, and it soon turns white."—*Essay on the Diseases of Plants.*

[61] *Vidi* understood.

[62] "At the close of the year 1665," says Dr. Hodges, "even women, before deemed barren, were said to prove prolific."

"After the cessation of the Black Plague, a greater fecundity in women was every where remarkable—a grand phenomenon, which from its occurrence after every destructive pestilence proves to conviction, if any occurrence can do so, the prevalence of a higher power in the direction of general organic life. Marriages were almost without exception prolific; and double and treble births were more frequent than at other times."—*Hecker*, p. 31.

[63] It is stated that on the decline of the Plague, 1665, those who returned early to London, or new comers, were certain to be attacked. In proof of this the 1st week of November, the deaths increased 400, and "physicians reported that above 3000 fell sick that week, mostly new comers."

See also Dr. Copland's Dict. Pract. Med. Epidemic and Endemic Diseases.

"The hardy mountaineer is a surer victim of paludal fever, whether he visits the low countries of the tropics, or the marshes of a more temperate climate, than the feebler native of those countries."—*Dr. R. Williams on Morbid Poisons.*

[64] "Substances presented to the gastro-intestinal surfaces, are mixed up with various secretions, mucus, saliva, gastric juice, bile, pancreatic liquor, and special exudations from the peculiar glands of each successive section, while aerial poisons, unmixed and unfettered, are applied at once to a surface on which, behind scarcely a shadow of a film, circulates the blood prepared, by the habitual action of the respiratory function, to absorb almost every vapour, and every odour, which may not be too irritating to pass the gates of the *glottis*."—*Mitchell on Fevers.*

[65] Hecker on the "Black Death."

[66] The stomach in some cases is no doubt the medium by which some diseases are contracted. It is well known, that in many places the water induces diarrhœa, the permanent residents, however, may not suffer, but all new comers are more or less affected by drinking it.

[67] "Similar effects have been experienced from the use of mouldy provisions."—*Dr. Lindley's Vegetable Kingdom.*

[68] "Untold numbers die of the diseases produced by scanty and *unwholesome food*."—*Southey.*

A large, nay, a most extensive adulteration of flour with plaster of Paris was detected not many years since. The flour was supplied by a contractor for the manufacture of biscuits for the navy.

[69] See Southey's Doctor, vol. ii. interchapter vi. p. 115, for an illustration of this subject.

[70] Both these patients died.

[71] "A good part of the clove trees which grew so plentifully in the island of Ternate, being felled at the solicitation of the Dutch, in order to heighten the price of that fruit, such a change ensued in the air, *as shewed the salutary effect of the effluvia of clove trees and their blossoms; the whole island, soon after they were cut down, becoming exceeding sickly*."

[72] The observation is originally taken from the City Remembrancer, 133.

[73] See Hamilton's History of Medicine, vol. i. p. 4.

[74] Feuchtersleben's Medical Psychology, p. 176, 177.

[75] Ibid. p. 321.

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