THE GEOGRAPHY OF DISEASE, AND THE FACTORS WHICH DETERMINE IT

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The study which forms the subject of this volume differs in many respects from a study of the geographical distribution of more concrete objects, such as certain groups of animals, plants, or minerals. Though constantly spoken of as if it were a material, tangible entity, disease is, in fact, no such thing. It is only a morbid phenomenon, or rather a group of morbid processes, in the tissues of a particular animal organism. In the language of logic, it is not even a phenomenon, but an epiphenomenon.

It is only in that class of diseases known or believed to be of Parasitic origin that there exists, in addition to the group of intangible signs and symptoms which in ordinary language constitute the disease, a tangible, palpable something, the distribution of which over the earth's surface may be justly compared with the distribution of mammals or insects, herbs or trees. But, on the one hand, it has not yet been shown that all, or nearly all, diseases are of this character; and, on the other hand, even where the parasitic origin of a human disease has been proved, it is well to bear in mind that the parasite and the disease are not one and the same thing, nor is their geographical distribution always or of necessity identical. There is good reason to believe, for example, that the parasites which are the known or suspected causes of such diseases as cholera, blackwater fever, malaria, guinea-worm disease, hydatids, and perhaps enteric and other fevers, may and do exist for long periods together outside the human body, and that there are uninhabited or sparsely inhabited tracts of the earth's surface where these parasites remain in the soil, or in water, or in the bodies of the lower animals, and where the human disease associated with them is only set up when man visitsthose tracts. In other words, the area of distribution of some disease parasites may be wider than the area of distribution of the human disease caused by them. In these instances the disease has a wider distribution potentially than actually. In others the reverse may be the case, and the area of distribution of the disease may at any given moment be actually wider than that of the parasite which gave rise to it. This, however, is exceptional, and can only occur in the case of certain affections of long duration, such, for example, as elephantiasis arabum, where the symptoms of the disease remain long after the filaria or other parasite which first caused them has disappeared from the tissues.

Any deviation from the normal, physiological processes ofhealth comes into the category of disease. Such deviations areas numerous in kind and causation as they are in degree. A large proportion of them are due to local, temporary, individual causes. Of the great group of diseases usually classed as surgical, perhaps the majority would come under this definition. Fractures and dislocations, burns and scalds, sprains and bruises, and generally the class of injuries due to "accidents" are all of this character,and a discussion of their geographical distribution would serve no useful end. On the other hand there is a large group of diseases, often classed as surgical, which are due, not to causes of the localor transient character just alluded to, but to some more generalcause. Such diseases, for example, as "cancer," certain forms ofulcer, urinary calculus, mycetoma, ainhum, trachoma and othereye diseases, though frequently needing the aid of the surgeon intheir treatment, are truly on the border-land of medicine and surgery. They show more or less definite relations to externalinfluences, they occur in more or less definite geographical areas, and hence a study of their geographical distribution not only offers many points of interest, but is essential to the solution of problems which the often obscure etiology of such diseases presents.

While on the one hand, therefore, only a few of the diseases commonly classed as "surgical" will come within the scope of the present study, a very large number, on the other hand,ofthe great group of " medical " diseases will require consideration. Even of these, however, not a few are due to other than general causes, or they present problems of comparatively little interest to the student of geographical pathology, and will consequently not be discussed here.

In the convenient, though not wholly satisfactory classification of diseases usually adopted, it is customary to group certain disorders together, such as the infective fevers, diseases due

to animal parasites, constitutional diseases and the like, and to placethe remainder in groups of diseases of the various "systems," such as the alimentary, the respiratory, or the circulatory system.

As knowledge advances the tendency is for these latter groups to become smaller and smaller. Many diseases which wereformerly classified as affections of the respiratory system (as, for example, diphtheria, pneumonia, and pulmonary consumption), of the alimentary system (as cholera and dysentery), or of the nervous system (as cerebro-spinal meningitis) are now known or suspected to be due to a specific infection, and are removed from the general class to some more definite class, as that of the infective fevers or infective granulomata. As such, their geographical distribution presents points of the greatest interest, and will be discussed in these pages. But there still remains a considerable number of affections which must, for various reasons, be passed over here. Some - for example, many diseases of the genito-urinary and nervous systems - must be omitted because their distribution, although presenting points of interest, is too imperfectly known to be of value. Others must be passed over,because their distribution, although more or less known, offers no special points of interest, or because the conclusions to be drawn from its study are quite disproportionate to the large amount of space needed to fully set it forth.

A study of the geography of disease would serve but little purpose without constantly bearing in mind the causation of the various maladies dealt with. In no branch of Medicine hasknowledge advanced more rapidly in modern times than in etiology. With improved powers of the microscope; with the birth and development of the science of bacteriology; with an ever-growing list of discoveries of parasitic infection in various diseases; with increased knowledge of the relation of disease to surrounding conditions, and its possible carriage by such media as air, water, milk, dust, fomites ; and finally with a wealth of new observations upon the part played by insects and by certain of the lower animals in disseminating infection — much that was formerly obscure and uncertain in the causation and mode of spread of disease has been made clear.

A large number of maladies have now been shown, beyond the reach of doubt, to be associated with the presence in the body of certain parasites, belonging either to the animal world, or to the still lower world of microscopic fungi. A still larger and ever-increasing group of diseases are believed to be produced in the same manner, though the specific organisms associated with them have not as yet been identified. To these groups of diseases the term parasitic, whether macro-parasitic, or microparasitic, may be conveniently applied. Until within the last few decades only a small number of diseases - such as scabies, and the various affections brought about by the intestinal worms, by the Guinea-worm and other comparatively large animal organism - were regarded as in any sense parasitic. The great majority of maladies were believed to be due to such causes as excess or diminution of some chemical constituent of the blood or tissues, or to some change in the chemico-vital processes of the body, brought about by errors in diet, by chill, or some other similar, non-living, agent. It is still permissible to suppose thatsome diseases, as, for example, diabetes, myxcedema, and perhapsscurvy, rickets, and gout, are of this character. But modern research has not only shown that the large group of infective or zymotic fevers are as truly of parasitic origin as the itch or the fluke-disease, but it has also shown that such superficially different diseases as elephantiasis and tetanus, leprosy and pneumonia, chyluria and malaria, endemic haematuria and pulmonary consumption, are no less truly caused by parasites.

This process of gradually transferring diseases from the groupof affections of chemical or chemico-vital causation to the group of parasitic diseases is constantly going on. A few years ago noone would have ventured to regard pneumonia or rheumatic fever as other than simple inflammatory processes, the result of chill. But the one has been practically proved, and the other is suspected, to be due to the agency of micro-parasites. It is, further, believedby many that such diseases as "cancer," scurvy, rickets, gout,urinary calculus, and a host of others, will ultimately prove to be of microbial origin. Some observers have even hazarded the suggestion that practically all diseases which are not due to such obvious external causes as poison, fire and frost, lightningstrokeor traumatic injury will be found to be due to parasites.

This view is an extreme one, yet not a little might be said in its favour. Disease is essentially a vital process - a deranged action, it is true, of living tissues, leading sometimes to their death, but, even then, still a living, vital process. The proof, then, ifthat were possible, that it is in all or most cases set up by theaction of a living thing, would only harmonise with what we alreadyknow of its nature and results. Moreover there are very few diseases that are

certainly known to be brought about by the sole, unaided action of non-living matter on the human frame.
Apart from the mineral poisons, and certain harmful gases and irritating dusts, the inanimate surroundings of man seem to have little power of producing disease in him, however potent some of them may be for traumatic injuries. Even the irritating dusts (such as those which set up certain well-known trade diseases) can scarcely be regarded as the sole agent in causing the disease, but rather as preparing the tissues for the action of harmful microorganisms. But the case is different with the living surroundings of man. The human animal passes his existence, as it were, in a medium of minute living organisms. The dust in the air he breathes is loaded with them; the water he drinks often swarms with them; the earth he walks on, the food he eats, the clothes he wears, all contain and bring into immediate contact with his body countless numbers of such organisms. Fortunately they are imperceptible to the unaided senses, and still more fortunately the vast majority are harmless. Some are, perhaps, beneficial, and may aid in the natural functions of the human body. Others are,and perhaps always have been, quite innocuous. Others again, there is reason to believe, were originally injurious and capable of disturbing the normal processes of healthy life in man, thus producing disease, but, as generation after generation has gone by, man has acquired an immunity to their attacks. In regard to many such micro-organisms the immunity acquired is, it may be supposed, not merely an individual immunity, but a true racial immunity, transmissible from generation to generation, and truly permanent so long as man shall continue to live in an atmosphere of these particular organisms.

There are other micro-parasites which appear to be harmless to man so long as he remains in health, but attack him and set up disease as soon as his powers of resistance are in any way weakened.Whether by original endowment, or by gradual adaptation to the needs of his existence, certain protective forces are now known to exist in the blood and tissues of the human body, which combat and destroy any harmful micro-parasites that may enter it. These forces are believed to be partly of the nature of cells (phagocytes), partly of the nature of chemical substances. Thousands of harmful micro-parasites may enter the body with each breath or with each mouthful, yet, provided the protective forces are present in sufficient number and activity, the invading parasites are destroyed or rendered harmless. But should these forces be diminished in number or activity, as the result of depressing influences, general or local disease is set up. Some of these parasites appear to be widely diffused all around us ; others are found only in the more or less near neighborhood of persons or animals actually suffering from the disease they produce. As examples of the former class may be named the various pyogenic organisms. These exist, there is every reason to believe, in considerable numbers, in the air or soil or dust, in most parts of the world, and must constantly gain access to the healthy human body; yet they do not set up suppuration unless and until they reach a tissue the vitality of which has been already lowered by chill or injury. In this group also may be placed some other pathogenic organisms, as those of tetanus and, perhaps, pneumonia, nasal catarrh, bronchitis, pleurisy, and others.

Finally there is a group of nocuous micro-organisms - including the larger number of pathogenic organisms - which are fortunately not found in abundance all around us, but only in the neighbourhood of a patient actually suffering from the disease they produce. Some of these parasites, as, for example, those of certain of the infective fevers, and the organism (not yet finally identified) of syphilis, seem to be nocuous to most people, no matter what their previous state of health, provided only that they are actually introduced into the tissues, and that an immunity has not been acquired by natural or artificial means. Others, as those of measles and scarlet-fever, are specially nocuous to young children. Some affect particular races. Some set up an acute febrile attack of short duration, while others are the cause of prolonged, chronic suffering and deformity.

Between the macro-parasites and the micro-parasites found in the human body, there is no true dividing line. The local irritation and general reaction set up by the presence in the body of a number of trichina? spirales, or of the echinococci of hydatid disease, find their analogues in the ulcers of the intestine and the febrile attack set up by the bacillus of typhoid, and in the bubo and the acute fever and delirium of bubonic plague. It would seem that a large proportion of the lower animal creation is capable of inflicting injury on man. The mode of inflicting the injury differs widely. Some animals have teeth and claws and hoofs, with which they bite and scratch and kick. OtheTs, such as many snakes, the scorpion, tarantula, mosquito, flea, and bed-bug can not only puncture or tear the skin but canat the same time inject a poisonous

substance, which may merely cause local irritation or may be absorbed and produce general symptoms and death. Others actually penetrate and take up their abode in man's tissues, inwhich they spend the whole or a portion of their existence.

The term parasite may be held to cover not only the lastnamed group, but also such organisms as lice, fleas, and bugs, which do not themselves enter the tissues, but live on the surface of the body and obtain nutriment from it. Closely analogous to these are the intestinal parasites, such as the tape-worms, the round, whip, and thread worms, which live in the intestinal canal, and, as they do not penetrate to the tissues, may in a sense be regarded as external parasites. A more serious form of parasitism is that in which the parasite actually enters the tissues. Internal parasites of this kind belong to very different zoological groups. The highest are those of the Insecta class, such as the chigo, or pulexpenetrans. Slightly lower are the parasites of the Arachnida class, such as the acarus of itch, and the demodexfolliculorum. Others belong to the sub-kingdom Anuuloida, including the parasite of hydatid disease, the Guinea-worm, the blood filariae, and the many other, nematode and trematode, worms which will be discussed in later chapters. Still lower in the scale of creation are the amceba? found in some cases of dysentery and in the contents of some liver abscesses ; the protozoal organism of malaria ; and the large group of schizomycetes, or bacterial parasites, the true zoological position of which is still uncertain.

It would be beyond the scope of this volume to discuss indetail the exact manner in which the micro-parasite produces the tissue changes which we call the disease. It is certain that in many, it is possible that in all diseases of the acute infective class, the multiplication of the micro-organism is associated with the production of poisonous substances, or toxins, the absorption of which leads to the febrile reaction and the other general symptoms of the disease. The ultimate explanation of all disease, whether acute or chronic, infective or non-infective, is still to be worked out by the joint labours of the physicist, the chemist, and the pathologist. The molecular repulsions and attractions of different cells or varieties of protoplasmic substances, the chemical combinations and decompositions associated with morbid cellchanges, the altered functional activity of cells or tissues or organs are all concerned in the production of the simplest disease. A priori, nothing is perhaps more remarkable than that some of the deadliest of human diseases should be due to the action of the smallest and simplest of living creatures - organisms consisting of a single cell of protoplasm, apparently differing in no way from the protoplasm which is the ultimate constituent of the cells of the human body itself. Yet this is no more remarkable than that the union of a single atom of hydrogen, a single atom of carbon and a single atom of nitrogen - that is to say, of three out of the four main chemical constituents of the human body - should result in the formation of prussic acid, one of the most deadly of known poisons, the absorption of which into the human body causes instant death. That there is any true analogy between the two phenomena it would perhaps be premature to suggest, but the resemblance is at least a striking one.

It is unnecessary to dwell at greater length upon the subject of parasitology, and the closely allied subjects of immunity and the development of pathogenic from harmless organisms. For a fuller consideration of these questions the reader is referred to other text-books devoted to such subjects. No discussion on the general causation of disease would have been complete without some account, however brief, of what this comparatively newscience has taught us. It has discovered with certainty the cause of many diseases, and it has shown in what direction the cause of many others must be sought. Whether it is destined to explain the causation of all disease and to reign supreme over the whole domain of pathology, the future alone can show. For the present it would seem permissible to retain the belief that at least some diseases are due to causes other than parasitic in their nature. Some - as for example myxcedema, and, as many believe, exophthalmic goitre - are almost certainly due to a diminution or excess in the tissues of certain substances produced by the action of a particular gland or set of glands; and there is nothing at present to show that the changes in the activity of these glands, leading to such diminution or excess, is in any way due to parasitic agency. Other diseases, such as epilepsy, some forms of rheumatism, migraine, neuralgia, atheroma oi the arteries, paralysis agitans, aneurisms of non-syphilitic origin, locomotor ataxia, chronic Bright's disease, waxy kidney, lymphadenoma, Raynaud's disease and many others, seem to be due to disturbances in the chemico-vital processes of the body or of special tissues, in the causation of which there is no reason at present to suppose that living parasites have any share.

While the recognition of the parasitic origin of a large number of diseases has thrown a flood oflight, not only upon their etiology, but upon their mode of spread and upon their relation to surrounding conditions, it has not yet explained all that is obscure in the natural history of disease. Even where - as, for example, in the case of cholera or plague - the parasite has been found, has been shown to be constantly associated with the disease, and may, within certain limits, be spoken of as its cause, there are still a number of phenomena in the behaviour of the disease which require explanation. These phenomena are particularly found in connection with the class of epidemic infectious fevers.

The sudden and marked changes in the behaviour of the two diseases just named, the great variations in prevalence and intensity of a score of other disorders, the appearance of a disease in one country and its disappearance from another, all open U P a number of interesting questions to which at present no quite satisfactory answer has been found. It has been suggested that all these phenomena find analogies in the insect world, fhe idea is no new one. The close resemblances between the behaviour of epidemic diseases and the flights and disappearances of insects was clearly recognised and discussed by many writers ln the eighteenth century. Linnaeus included in his published w orks several memoirs by others on the subject. One of the most interesting of the late Sir Henry Holland's essays discusses the question at length. The knowledge gained since then by the actual proof of the existence of micro-parasites as the cause of disease - then only suspected - has scarcely altered the character of the problem, though it has altered its terms. In Linnasus's time, when an author hazarded the suggestion that small-pox, measles, the plague and other diseases might be caused by minute animals, he spoke of them as insects - "acari" of different species. In Sir Henry Holland's time the microscope had already shown the occurrence in nature of animals still lower than insects - of infusoria, and similar minute, lowly organisms, and it was to these that the causation of disease was tentatively ascribed; while already the probability that other still lowlier organisms existed and would ultimately be found, was fully recognised.

The still lowlier organisms have now been found, in regard at least to many diseases. And with their discovery, the terms of the problem, as just stated, have changed. It is now known that these diseases are not due to insects, but to forms of life infinitely lower - almost, it would seem, at the lowest end of the scale of creation. It is now known that if the general behaviour of these diseases presents an analogy with that of insects, it is only an analogy. The resemblance, it is true, is often very striking. Some insects, for example, like some diseases, have permanent breedinggrounds in special and relatively limited areas. They are numerous here in some years, rare in others. They may change their breeding-grounds. They migrate in certain years to other areas;they fly in swarms or in small numbers; they take long flightsover thousands of miles and appear in countries where they werebefore unknown ; they disappear almost as suddenly as they came, or they break tip into patches, remain more or less pArmanently in the newly-invaded territory, or gradually die out. In all these respects, their behaviour shows complete analogy with the behaviour of such diseases as cholera or plague, influenza or dengue.

But if the attempt be made to push the analogy too far, itbreaks down. Insects are highly organised creatures; they areadapted to a highly developed form of social existence; they are sentient; many of them have extraordinary powers of intelligence; and finally they are endowed with powers of locomotion, enabling them to pass over distances which in some instances may be measured by hundreds of miles. But the lowly micro-organisms believed to be the causes of plague or cholera, of yellow-fever or diphtheria, have none of these characters. It is more especially in their powers of locomotion that they differ from insects. They have, indeed, alone and unaided, almost no powers of locomotion. The most that an individual micro-parasite can do in this respect is to wriggle over short distances in a liquid medium, and the most that the mass of micro-parasites can do is to spread in a saprophytic state by multiplication at the edge, as a patch of ringworm spreads. To pass from one region of the earth's surface to another they are dependent upon the movements of other things, animate or inanimate. They must be carried in the water of a running stream; in the tissues of a man, a rat, or an insect; in a bundle of " infected " goods ; perhaps by the wind. Their locomotion is involuntary. They cannot, as insects appear to do, choose when and whither they will migrate. They cannot, when their breeding-grounds become unsuited to them, or when their supply of food seems failing, take wing in a body and fly, as insects do, with almost conscious, intelligent, ordered movement in a definite line to other and more hospitable lands. They seem to be left - so far as locomotion is concerned - to the chapter of accident.

Yet, in the natural history of many epidemic diseases there are phenomena which it seems difficult to explain on the theory of a mere accidental carriage of a micro-parasite. Much has been written upon the "cyclical" character of many diseases. Not merely such classical examples as influenza, cholera, and plague, but other diseases, as diphtheria, scarlet-fever, small-pox, and measles, have all shown a tendency to years of special prevalence, with intervals of comparative inactivity. These "cycles" are of no definite length; the average for any given disease is often widely departed from by that disease. But they exist, and to ascribe them to a mere chapter of accidents is an unsatisfactory explanation.Still less satisfactory is it in regard to such diseases as cholera and plague and influenza, which remain for long years together confined to certain limited areas, and at irregular intervals spread, without apparent reason, to a large portion or the whole °f the inhabited world. No doubt in such instances the accidentalcarriage of the micro-parasite plays some part; probably of more importance are the wide variations which may be supposed to take place from year to year in the vitality and powers of multiplication of the micro-parasite; possibly there is some additional factor, still to be discovered, to explain fully all that is obscure in the behaviour of these diseases.

What that factor may be it is difficult even to surmise. The micro-parasites of disease are an integral part of organic creation. Like all other living creatures they are subject to the laws of evolution, of the struggle for existence, and the survival of the fittest. They are perhaps preyed upon by other micro-organisms or by creatures less lowly in the scale of creation. The antagonism between different disease-germs has often been suspected, though it has never yet been proved. From early historical times it has been repeatedly noted that an epidemic of one disease has been accompanied by a lessening or a disappearance of some other disease.- But the experience of one epidemic has been contradicted by that of another of the same disease elsewhere or at a later date; and no proof has as yet been brought forward of a constant, essential antagonism between any two diseases, or the parasites that cause them.

But if there is no proved antagonism between any two diseasegerms, there may, for aught that is known to the contrary, be a keen antagonism between one disease-germ and some other living creature - animal, vegetable or fungoid. The wide fluctuations from year to year in the numbers and activity of a given diseasegerm may perhaps depend not only upon fluctuations in its own vitality and powers of multiplication, but also upon fluctuations in the particular creature of which it is the normal prey. Should this prove to be the case, then it may be supposed that when the latter are numerous and active the former will be destroyed or kept within normal limits, and that when the reverse is the case the disease-germ will flourish uncontrolled, and the disease associated with it will become epidemic.

It may be that this, or something analogous to this is the explanation of the " cyclical " variations of many epidemic diseases. It presupposes, however, that a large portion, or even a principal portion, of the life of a disease-germ is spent in a saprophytic state, outside the human body, where alone it could fall a prey to the other supposed living organism. It can scarcely be applied in explanation of a large number of the infective fevers, the micro-parasite of which appears to pass the whole, or almost the whole, of its existence in the tissues of persons actually suffering from the disease. In regard to such diseases, if theirwide fluctuations from year to year are to be explained by fluctuations in the number and activity of external forces, favourable or inimical to the parasites of those diseases, it seems almost necessary to suppose that these forces exist within the human body. In other words, while it is necessary to suppose that the virulence and powers of multiplication of disease-parasites differ widely in different years, it is equally necessary to admit the possibility that the receptivity of their human host, or his powers to withstand their attacks, may also differ widely.

In olden days great epidemics were attributed either to such highly improbable causes as eclipses of the sun or moon, combinations of the stars or planets, the appearance of a comet or some other celestial event; or to such possible causes as great and unusual incidents upon this globe itself - earthquakes, openings of cracks and chasms in the earth's crust, inundations and overflows of great rivers, the pestilential emanations from the unburied bodies of persons overwhelmed by famine, by war, or by some great cataclysm. There is nothing to show positively that one of these particular events has been the cause of any of the great historical epidemics of disease. Famine and war bring many diseases in their train, it is true, and the emanations from masses of unburied bodies may lead to the local prevalence of certain diseases; but none of the historical pandemics of cholera, of influenza, of plague, of small-pox, or of any other disease has been traced to such causes. It is impossible now to accept so simple an explanation of a plague pandemic as the opening of a hole or gulf in the

earth, in Chaldea, whence issued a pestilential vapour that struck all it met with the plague - an explanation which satisfied the historians of the time of Marcus Aurelius.

Yet in regard to these earth-changes or terrestrial spasms and their relation to disease, it may be well perhaps to guard against over-scepticism, and to admit the possibility that such explanations of epidemics, though never absolutely proved in any mdividual instance, may contain a germ of truth. Some twelve or thirteen years ago one disease - influenza - swept round the entire globe, and more than round it. This behaviour of the malady was attributed by some to great inundations in China; while others pointed out the close resemblance between the sweep of the disease round the earth and that of the dust raised some years before by the great cataclysm of Krakatau, near Java. That dust was believed to have been carried in the course of a few months not once, but many times, round the world. While the Chinese inundation theory was certainly wrong, as the last pandemic began, not in China, but on the borders of European and Asiatic Russia, the other suggestion is deserving of some consideration. The analogy between the behaviour of influenza and that of the dust of the Krakatau eruption is at least as striking as the analogy, already discussed at length, between the behaviour of many epidemic diseases and that of insect-swarms. Attention, it will be remembered, was drawn to this latter analogy long before the true causation of such diseases was known ; and, although the suggestion that these diseases were actually caused by insects was later shown to be wrong, yet it went strikingly near the truth in that it presupposed an animate instead of an inanimate cause for them. May not the suggestion that earth-changes or terrestrial shocks share inthe causation of epidemics go equally near to some other, yet undiscovered, truth - the sought-for, but yet unknown something which seems to be needed to explain all the phenomena of epidemic disease?

Attempts have been repeatedly made to classify diseaseson a geographical basis, grouping together those that have a universal distribution, those that are found mostly in cold or temperate climates, and those that occur mainly or solely in tropical or sub-tropical countries. Such classifications are always interesting, though they can never, from the nature of things, be of a final character. With the exception of those disorders which are practically universal, almost no disease can be said to have a permanent geographical distribution. Apart from such marked examples as cholera, influenza, and the other typical "epidemic" diseases, whose distribution varies enormously from year to year, or from century to century, there are many diseases whose limits of diffusion are not yet reached - - whose history is, so to say, "in the making." Small-pox, for example, has not, as yet, been introduced into New Guinea, Tasmania, New Zealand, and many of the Pacific Islands. The chigo has in the past few years spread for the first time in history over the continent of Africa and appeared in Madagascar and India. Sleeping sickness is gradually extending over wider and wider areas in Africa. Syphilis has not yet reached the possible limits of its diffusion, and Greenland, parts of America, and of South Africa have not as yet seen the disease - though it can scarcely be doubted that they will sooner or later, as their traffic with the rest of the world increases. Plague has in the past few years appeared in the western hemisphere and in many places south of the equator; yet but a few years ago it was held - and apparently with justice - that this malady could not extend to the New World or to southern latitudes. Many other examples might be quoted in illustration of the same fact, and of the caution needed in any attempt to classify diseases on a geographical basis.

Without aiming at any strict classification of this kind it will suffice here to group together certain diseases whose distribution over the earth's surface has been more or less alike.

Some diseases have an almost world-wide distribution. Cancer,diarrhceal disorders, mumps, measles, pneumonia, leprosy, rheumatism, typhoid fever, tubercle, whooping-cough, and many others have occurred at some time or other in almost all parts pi the inhabited world. They have shown themselves quite independent of lines of latitude or isotherms. Some diseases, as scarlet fever and diphtheria, are found mainly m temperate or cool climates, and are rare or unknown in and near the tropics. Others, as whooping-cough, cerebro-spinal fever, rheumatic fever, scurvy, and typhus fever, though occurring to some extent in all latitudes are more common or more severe, or both, in the cooler parts of the earth.

In a few instances, of which malaria and dysentery are the most striking, the reverse is the case, and the disease, though found m almost all latitudes, becomes more common and more severe towards the equator.

Many diseases are practically confined to warm latitudes; among the most typical examples of this class are dengue, "Mycetoma, liver abscess, phagedenic tropical ulcers, oriental sore,yaws, the bilharzia disease, ankylostomiasis, the various filarial isorders (elephantiasis, chyluria, etc.), the guinea-worm disease, and many others.

Some have a still more restricted range and are found only in comparatively small portions of particular continents, as, for example, verrugaperuviana, ainhum and goundou.

Another important group includes certain diseases which remain endemic in comparatively limited areas for long periods together, and only at irregular intervals spread more or less widely over the earth's surface. To this class belong cholera, plague, and yellow fever. The first of these three diseases has several more or less permanent endemic centres in the Far East, all in or near the tropics; yet as an epidemic it has spread at times to almost all parts of the world. The second has also many endemic centres, but of a less permanent character, and not all in or even near the tropics; its epidemic diffusion has in the past been quite as wide as that of cholera. The third is endemic only on the tropical coasts, eastern and western, of the Atlantic Ocean, and its epidemic diffusion has been much more restricted than that of either plague or cholera.

Ignoring for the moment the disturbing influence of season and elevation above sea-level, the earth may be regarded as becoming progressively warmer from the poles to the equator;and this variation in temperature has clearly a powerful influence upon the distribution of many diseases. But it is not the only factor in determining their distribution, nor is it in all instances the most important one. Even in regard to diseases caused by micro-parasites the direct effect of temperature is by no means uniform. The favouring action of warmth upon all living organisms and the greater wealth and variety of the larger flora and fauna of tropical and sub-tropical regions over those of the temperate and cooler zones of the earth, might well warrant the expectation that all such diseases would be more rife and more severe in the former than in the latter. Yet this can scarcely be said unreservedly to be the case. It would seem that the influence of climate upon disease is shown rather in regard to the variety of disorders met with than to the frequency or intensity of each disorder. As might have been anticipated, the disease-list is a longer one in warm countries than in cold. In most tropical and sub-tropical lands all, or nearly all of the ordinary diseases of temperate climes are found to exist, while there are in addition others that are unknown in the latter. The disease-flora is, in brief, richer in the warmer regions of the earth. But when each disorder of temperate climes is considered separately, and traced from the pole to the equator, it is not always found to become progressively morecommon or progressively more severe. A gradation of this kind was, it is true, mentioned above in regard to malaria and dysentery, and to these may perhaps be added cholera and plague in their epidemic manifestations. But a still longer list has already been given -of diseases which are commonest in temperate or hot climates, and actually become rarer or less severe as the equator is approached. It will, further, be shown presently that many - almost the majority - of the ordinary infective fevers are most prevalent in the cool and not the warm season of the year. That this seasonal variation in disease is due not solely to changes of temperature but also to other factors - such as the closer aggregationof people in houses, lessened ventilation, diminished sunlight in the cool season of the year - there can be little doubt; and the same or similar conditions may to some extent be held to accountfor the distribution of these diseases, on a large scale, over the earth's surface.

The seasonal variation of diseases has an obvious, if indirect, bearing upon their geographical distribution. In general terms the diseases which have shown a tendency to prevail mostly in the cooler season of the year, both in warm and cool latitudes, have been small-pox, influenza, measles, diphtheria, croup, whooping-cough, pneumonia, inflammatory affections of the respiratory passages, typhus fever, erysipelas, cerebrospinal meningitis, puerperal fever, and rheumatism. On the other hand, many affections of the digestive organs, as diarrhoea, dysentery, and cholera, have always been most active in the warmer months. J fague has been for the most part a warm-season disease in temperate climates and a cool-season disease in the tropics. Scarlet fever, relapsing fever, and many others have shown no very definite or constant seasonal relations. In regard to a large number of diseases, particularly those occurring in the tropics, the seasonal variations have been less dependent upon temperature than upon rainfall; in other words, they have been less a question ofthe difference between cold and warm seasons than of the difference between wet and dry seasons. In many war countries whole course of social life is largely determined by the annual recurrence, at a more or less constant date, of "the rains"; and each period of the year - whether it be the

commencement of the rams, the rainy season proper, the decline of the rains, or the dry season - has its own character in regard to the prevalence or scarcity of some particular disease or diseases.

The influence of altitude above sea-level upon the distribution of disease is far from uniform and is not always easy to determine. The lowered atmospheric pressure and the lessened temperature found at considerable heights are usually combined with a greater freedom of the air from organic impurities, and with the presence of a scantier population, living a more or less isolated existence, and holding rare communication with the rest of the world. Such conditions not only lessen the chances of the importation of communicable diseases, but they are unfavourable to the prevalence and multiplication of the infecting material when imported. Hence many diseases, as, for example, tubercle, cholera, malaria and dengue, are rarer at high than at low levels. But in a large number of instances a high altitude has proved no bar to the epidemic, or even the endemic, occurrence of disease ; and not only those just named, but many other disorders that are most common at low levels have prevailed with intensity at great heights. One disease - verrugaperuviana - is found only at altitudes exceeding 2509 feet above sea-level. The very obvious fact that a high altitude in the tropics may present conditions of climate and temperature and, consequently, of disease prevalenceresembling those of the temperate or cooler zones is well illustrated by the behaviour of typhus fever. When that disease occurs in or near the tropics it is only or mainly at considerable heights, while in more temperate zones it prevails indifferently at high or low levels.

From the early days of medical observation the character of the soil has been thought to exert a powerful influence upon the prevalence and distribution of disease in man. The obviously unhealthy nature of many low-lying, marshy lands, the remarkable and apparently arbitrary distribution of some diseases, and the knowledge, which must have been acquired at an early period, that a dry porous soil is much healthier than a moist, impervious one, would all tend to encourage this view ; and it was further strengthened by the belief, at one time universally held, that many diseases were due to "miasmas" or harmful emanations from the earth. The subject is one that has scarcely yet been finally worked out; but it would seem that what may be called the strictly geological characters of a soil have a less powerful influence upon disease distribution than its physical properties - its temperature; its dryness or moistness; its perviousness or imperviousness; its purity or impurity in regard to contained organic matter; and its relation to human dwellings. It has long been known, for example, that a damp and impervious soil is peculiarly favourable to the prevalence of consumption, lung diseases in general, rheumatism, and other affections ; and there is good reason to believe that it is a leading factor in the distribution of diphtheria, and, possibly, of cancerous diseases. Cholera and typhoid fever have shown on many occasions that they are largely influenced by variations in the height of the water contained in the soil. Diarrheal disease, particularly the diarrhoea of infants, has shown a marked parallelism with the rise and fall of the temperature of the soil. Yellow fever, typhus fever, and perhaps plague, Mediterranean fever, and other diseases, have seemed to require, or at least to be favoured by, the presence of organic matter, and particularly of animal pollution in the soil.

Other pathogenic micro-parasites would seem to spend one portion of their existence in the soil. The tetanus bacillus has a wide distribution in many varieties of soil ; the bacillus of malignant cedema is found mostly in soil containing much putrefying matter, such as garden earth that has been recently manured; the anthrax bacillus, the actinomycosis fungus, the mycetoma fungus, would all seem to be capable of living in a saprophytic state for longer or shorter periods in or on the soil. The micro-organisms °f typhoid fever, yellow fever, plague, and many other diseases are thought to possess the same power. The soil, further, plays an important part in the diffusion of some of the animal parasites to which man is liable. The chigo flea lives in or on warm sandy soils or on the earthen floors of human dwellings. Ankylostomum duodenaleprobably spends the larval stage of its life-history in moist earth, and is transferred to man either by means of food that has been contaminated by the earth, or by actual earth-eating (geophagy).

Finally, earth-disturbance on a large scale has been frequently tollowed by the appearance of certain diseases in an epidemic °rm. The diseases that have been observed to occur under such rcumstances have been malaria, blackwater fever, ankylostomiasis, and that form of fever to which the name of typho-malaria °r malarial typhoid has (probably erroneously) been given.

The exact influence of racial susceptibility or immunity upon disease-distribution is not always easy to determine. Differences of race are so commonly proved to be associated with differences in mode of life, in degree of "acclimatisation," in amount of exposure to infecting material, in readiness to take preventive measures, and the like, that it is often far from easy to say whether a difference in disease-incidence between any two given races should not be ascribed to one or other of these factors and not to a true difference in racial susceptibility. All that can be positively stated is that some races do seem to be more susceptible to certain diseases than others, while in a few instances a true racial immunity may with some reason be suspected. In the tropics, for example, the white races appear to be far more susceptible to malaria, liver abscess, scarlet fever and typhoid feverthan the coloured races; while on the other hand they are much less likely to become subjects of elephantiasis, chyluria and other filarial diseases, the Guinea-worm, and many skin diseases, as, for example, craw-craw, tineaimbricata, and pinta.

The African negro is peculiarly liable to tubercle, small-pox, tetanus, and cerebro-spinal meningitis; and such diseases as ainhum, goundou, and sleeping-sickness, and such parasites as the filariaperstans, filarialoa, filariacliurna and some others are solely or almost solely confined to the negro race. On the other hand the negro enjoys a high degree of immunity from yellow fever and, to a less extent, from malaria. To the skin diseases named above as rare in the white races may be added yaws or framboesia, the frequency of which in any part of the world would seem to be determined largely by the depth of colour - or in other words by the amount of pigment in the skin - of the population. The Mongolian races have shown themselves remarkably susceptible to many of the infective diseases, both acuteand chronic, and to ophthalmia and trachoma ; and a few animal parasites, as for example distomumpulmonale and distomum sinense, seem to be almost peculiar to them.

That insanitary conditions on the one hand, and, on the other, man's conscious efforts to remove these and to prevent and control diseases of all kinds, have a very considerable share in determining the distribution of disease can scarcely be questioned. Sanitation and disease-prevention are both sciences of modern growth. They are practised to a very limited extent in the large majority of territorial areas of which the inhabited earth is composed, and are, for all practical purposes, entirely absent from not a few. In only a very small number of countries can they be said to have reached a high level throughout. In none have they attained the possible maximum. Their influence, therefore, upon disease-distribution is still far from being as powerful as it might be. They have not yet apparently succeeded m completely and finally removing from the face of the earth any of the known diseases to which man is liable; and it is easyto point to a considerable list of disorders - tubercle, syphilis, diphtheria, cancer and others - which, in spite of human effort, have, taking the world as a whole, become more instead of lessrife in recent times. But on the other hand there is a vast and ever-increasing mass of evidence proving clearly that the control of many diseases is very largely in man's hands alone. A generallyraised level of personal and communal hygiene and an ordered Public Health Administration in the more civilised countrieshave not only markedly lessened the general death-rate from allcauses, but they have greatly reduced the power for evil of not a few special diseases, and all but extinguished some. Even in regard to the diseases named above as having become morefrequent in recent times, it was necessary to add the proviso 'taking the world as a whole," for three at least of the four named have become less prevalent or less fatal in those countries where serious efforts have been made to control them.

In England, where more persistent, more general, and more costly efforts to improve sanitation and control disease have been made than in any other country, it has been clearly shown that these measures as a whole have almost extinguished typhus fever, dysentery, and malaria; they have led to a marked reduction in typhoid fever and pulmonary consumption; and they have shown that such diseases as cholera and plague may for long periodstogether, and in spite of repeated importation of the infection, De kept at bay and at least prevented from gaining any serious hold upon the country.

Special health measures have succeeded in all countries in controlling special diseases. The draining of marshes and swamps nas practically freed Holland and England from malaria; and similar works, combined with a war against the malaria-bearing mosquito, are leading to a striking diminution of the same disease in Italy, the West Coast of Africa, Cuba and elsewhere. Provision of a pure water-supply and care to prevent the consumption of fouled water have had an enormous share in controlling such diseases as cholera, dysentery, and typhoid fever. Careful inspection of meat has proved wholly successful in many countries in preventing

trichiniasis. The muzzling order and other measures, particularly those concerned with the importation of animals from abroad, have almost extinguished rabies and hydrophobia in England. The introduction of vaccination by Jenner at the end of the eighteenth century led to an enormous diminution in small-pox in all those countries where it was practised ; and the disease has almost ever since been less or more prevalent just in proportion as efficient vaccination and re-vaccination have or have not been carried out. Methods of protective inoculation against plague, typhoid fever, yellow fever and some other diseaseshave been recently introduced with promising results; and in regard to the first-named at least, the method has been so extensively and successfully practised in India and elsewhere as to rank already as an important factor in the local distribution of the disease. Syphilis and other venereal disorders have beencontrolled by judicious legislation and a healthier tone of publicand private morals. Scurvy is no longer the scourge that it was at one time of gaols, barracks, and ships, and recent experiencehas shown that even an Arctic expedition may be successfully carried through without a single loss from this disease.

But when, on the other hand, no attempt is made to removeinsanitary conditions, and disease is allowed to run its own course unfettered by any effort on the part of man to control it, the results are very different. Every one of the maladies named in the last two paragraphs, and a host of others - as ophthalmia, diarrhceal diseases of all kinds, erysipelas, puerperal fever, phtheiriasis and many other skin diseases, all the affections associated with animal parasites - are not only more common,but may literally run rife where man lives in the midst of filth and refuse, where drainage and a pure water-supply are unknown,and where organised public effort to control specific diseases is absent or impotent.

In this resume of present-day knowledge as to the influence of different external factors upon the distribution of disease, the large class of "communicable" disorders has, of necessity, been most frequently mentioned. It is disorders of this class whose geographical distribution presents most points of interest and is of real service in explaining their nature and causation. In the diffusion of such diseases man's movements must always take a leading share. In the case of the chronic infective disorders, as syphilis, leprosy and (perhaps) tubercle, man's movements have apparently been alone responsible for their spread. In the case of the acute infective fevers this factor must also be an important one in their distribution; though in regard to many, as was pointed out above, it is probably not the only one.

Instances of the carriage of disease by man from one part of the earth's surface to another are innumerable - not only by the movements of individuals but by the movements of men in masses. Emigrants have carried leprosy and hydatids from Iceland to Canada and the United States. Traders and explorers have on countless occasions brought influenza, measles, syphilis, small-pox, and many another disease to communities where they were before unknown.Chinese labourers have been the principal agents in the distribution of leprosy in Australia, the Malay Peninsula, and the Far East generally. The great movements of peasants in Russia, who leave their homes in bodies and seek work in other parts of the country, have repeatedly been the means of spreading syphilis, ophthalmia, cholera, and other diseases. Beri-beri, plague, yellow fever, cerebro-spinal meningitis and many others have been transported by ships over thousands of miles, and often without losing any of their virulence by the way.

The movements of men associated with war have proved to be great factors in the distribution of disease. Here, no doubt, mere movement is not the only factor at work, but it has largely aided the other factors concerned. Typhoid fever, malaria, socalled typho-malaria, syphilis, measles, scurvy, small-pox, have all at some time or other been spread as the result of military movements. Typhus fever was widely diffused in Europe by the Napoleonic wars, and rapidly diminished in prevalence when those wars came to an end on the field of Waterloo,Leprosy was carried by refugees during the disturbances in Crete a few yearsago to many parts of the Eastern Mediterranean. The Crusadeswere believed to have aided in the diffusion of more than one disease. It is, however, unnecessary to multiply instances further. There is scarcely a war in ancient or modern times which does not furnish examples equally striking with those just quoted.

Pilgrimages to religious shrines have often aided in diffusing disease. The great annual flow of Moslem pilgrims to "and from the western shores of Arabia has repeatedly been the means of bringing cholera to the Red Sea and of spreading it widely elsewhere; and there can be little question that this annual concourse of people also aids in distributing small-pox and other communicable diseases less striking and less dreaded than these. The same statement holds

good for those gigantic gatherings of pilgrims at bathing and other religious festivals at Hardwar and elsewhere in India; the constant flow of Shiite pilgrims to the holy burying-grounds of Kerbela and Nedjef near the Turco-Persian frontier; and the annual gathering and dispersal of traders and peasants at the great fair of Nijni Novgorod on the Volga.

The geographical distribution of "communicable" diseasesdepends not a little upon the channel by which they are transmitted from man to man. This varies very widely. Some, as, for example, syphilis, gonorrhoea, ophthalmia, and possibly oriental sore, yaws, and other skin diseases require that the actual secretions of an infected person shall reach the whole or abraded skin or mucous membrane of a healthy person before the latter can contract the disease. The term contagious should be strictly limited to this class of disorder. In others the transmitted material is less gross, and, whether of the nature of a microparasite or not, is given off by the patient's body, exists in the air about him, and is carried to a greater or less distance by the air. In typhus fever this distance is perhaps only a few feet, in smallpox it may be measured by fractions of a mile. The part played by the air in the transmission of many other diseases has been much discussed and is still uncertain. Dust, which is merely a collection of particles, organic and inorganic, of "matter misplaced" may contain the germs of infectious disease or even fragments of the dried discharges of the contagious diseases, and the air carrying such dust may thus be the bearer of the disease. Ophthalmia, there can be little doubt, is often spread in this way; typhoid fever is thought by many to be a dust-borne disease; and in the aerial diffusion of small-pox it is reasonable to suppose that dust containing fragments of dried small-pox scabs is the main carrier of the infection. Malaria, at one time regarded as the type of an air-borne disease, is now known to be carried not by mere air-currents but by the agency of winged insects.

In the case of some diseases the infecting material is carried by water. Cholera, typhoid fever, and dysentery are all spread very largely, perhaps mainly, by this means. Goitre and urinary calculus have been thought to depend upon the consumption of particular kinds of water. The bilharzia disease, ankylostomiasis, Guinea-worm disease and other affections caused by animal parasites are certainly or probably spread by the agency of water. Several parasites of this nature pass the larval stage of their existence in the bodies of some minute fresh-water animalcule and gain access to man in one of two ways - either through his drinking water containing such infected animalcules or free lame, or from the larva-containing water coming into contact with the surface of his body.

Some water-borne diseases may be carried over considerable distances by this means. Cholera, the archetype of this class of disease, has on several occasions been spread over a great part of a large and populous city by a contaminated public water-supply; and there is good reason to believe that such immense streams as the Elbe, the Volga, the Don, the Neva, and many other rivers have been the means of carrying the cholera virus over very long distances.

A large number of communicable diseases are transmissible by means of infected clothes, linen, merchandise and other fomites. The virus of small-pox, of scarlet fever, of measles, of plague, and of many other diseases may cling to the furniture, the bed-linen, the clothes, or any and every inanimate object that has been in the near neighbourhood of a patient suffering from the disease. In this position it may retain its virulence for long periods together, and if such infected articles are moved to other places they may carry the virus with them and reproduce the disease elsewhere. By this means infective diseases have been carried over much longer distances than they have ever been carried by the air or by water. It has probably been one of the most powerful means of distributing many communicable maladies; and there is reason to believe that in many of those instances of apparent carriage of infection by human beings from country tocountry or from hemisphere to hemisphere, the infecting material has really been carried in the clothes or belongings of the person, and not in his tissues. This must always be the case when the infection has been carried over very long distances - distances which take longer to traverse than the incubation period of the disease. It must equally certainly be the case in those well-known instances where a person has come from an area where a particular malady was epidemic to another area free from it, and where, though not himself developing the disease, his arrival has been followed by the appearance of the disease in other persons in his immediate neighbourhood.

But man and his inanimate surroundings are not the only means by which communicable disease is spread. The belief that the lower animals are attacked at the same time as man by

epidemic diseases is almost as old as the history of disease itself. In the early historical records of plague and pestilence nothing is commoner than to find that a murrain among beasts and birds or both prevailed at the same time as the human disease. Modern observation has shown more precisely the true relation of the lower animals to disease in man. It has shown that man obtains the infection of some maladies, as, for example, anthrax, glanders, farcy, foot-and-mouth disease, and hydrophobia, solely, or practically solely, from animals already suffering from them. Such diseases are, in fact, essentially animal affections, and only attack man by accident. It has further shown that some essentially human affections may accidentally attack the lower animals, which thus become the carriers of infection. Human influenza is believed to be transmissible to horses, cats, and other domestic animals. Diphtheria, or a disease closely allied to it, has been seen in birds. A form of infectious pneumonia has been known to attack parrots and be transmitted from them to man. Scarlet fever may perhaps affect cattle ; and it is still a debated question whether the tubercular disease of cattle and other animals is or is not transmissible to man. In at least one disease the lower animals are not only capable of being attacked but appear to be one of the principal means of diffusing the infection over the earth's surface. The part played by the rat in the spread of plague will be discussed in the chapter on that disease, whereit will also be shown that mice, monkeys, bandicoots, squirrels, cats, and possibly marmots and other animals may all be carriers of the infection.

Many of the animal parasites to which man is subject pass a portion of their existence in one or other of the lower animals, and here the animal must be regarded as an essential, indispensable link in the transmission of the associated disease. Taenia solium and trichina spiralis complete their life-history in the pig;taeniamediocanellata in horned cattle; bothriocephaluslatus in certain fish; taeniaechinococcus - the parasite of hydatid disease - in the dog, sheep, or cattle. Such parasites can only pass to man where he is brought into relation with animals, living or dead, which are the subjects of them. Most of them gain access to his body through eating imperfectly cooked beef, pork, or fish containing them. Others, as for example taeniaechinococcus and perhaps ascarislumbricoides, probably escape from the animal in the excreta, and are conveyed to man in dirty drinking water or by contaminated hands or food.

Still lower in the scale of creation, many members of the insect family are found to act as the carriers of disease. Houseflies, mosquitoes, fleas, bugs, lice - any or every insect that may crawl on the body of a person suffering from an infectious diseaseor batten on his excreta, and then pass to the body of another person, may be the means of directly carrying the malady, through some portion of infecting material clinging to its legs or body. Or the insects may carry the infecting material to milk, or water, or solid food, which would then give the disease to any one swallowing it.

In other instances the infecting material, or in other words the parasite, actually enters the insect's body. This would appear to occur most usually, if not solely, in the case of diseases the parasite of which exists in the peripheral circulation, and the only insects capable of transmitting them are those which suck men's blood. The most dangerous insect in this respect would seem to be the mosquito. It has been shown to be the principal carrier of the malarial organism. A mosquito, though possibly of an other species, is the extra-human host of the filariasanguinis hominis (F. Bancrofti), and probably of many other varieties of filariae ; and strong evidence has recently been brought forward that certain mosquitoes may be active carriers of the yellow fever virus. Plague is also believed by some to be spread by the agency of insects ; not, however, by the mosquito, but by fleas and other body-vermin found on man, on rats, or on other animals suffering from the disease. The cockroach has been suggested as the possible host of some of the taeniae to which man is subject.

Finally, and as probably the lowest of all animals in the scale of creation that are capable of becoming the hosts of human parasites, must be named a fresh-water cyclops which has been shown to act in this way for the Guinea-worm; and it is far from improbable that later observation will show that some similar lowly organism is the extra-corporeal host of bilharzia haematobia and other human parasites.

In the case of those human diseases, the parasite of which passes half its life-history in some of the lower animals - whether a mammal, fish, insect, or crustacean - it is clear that the geography of the disease must be largely determined by that of the particular animal in question. There are in fact three essentials for the prevalence of such diseases - the parasite, the human subject, and the extra-human host. The geographical distribution of such diseases

may differ from that of either of these essential elements taken separately; and in the absence of any one of them it must rapidly die out. The influence, further, of such external conditions as temperature, climate, elevation above sea-level, soil and season, upon the distribution of the disease must be somewhat more complex than in the case of other diseases; for such influence must act not only on the parasite itself, and the receptivity of the human subject, but also on the numbers and activity of the particular animal or insect which serves as the extra-human host.

This rapid survey of the forces at work in determining the geography of disease will, if it serve no other purpose, at least show that the distribution of diseases is a highly complex matter. In the case of each disorder to which man is liable, the areas of the earth's surface in which that disorder is met with, and its differing degrees of frequency in different parts of those areas must be regarded as the resultant of all, or of many of the factors, the most important of which have been discussed in this chapter.

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