Abstracts of lectures on malarial fevers / by W. North.

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ABSTRACTS OF LECTURES

ON

MALARIAL FEVERS.

By W. NORTH, B.A., F.C.S.,

Research Scholar of the Grocers' Company.

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LECTURE I.

Distribution and General Conditions of Prevalence: History in the Province of Rome.

The wide distribution of malarial fevers and their disastrous effects upon the population of countries in which they prevail, and the obstacle they constitute to all material progress, is not generally realised, whereas it is a subject which should attract the attention of governments, inasmuch as these diseases materially increase the cost of administration. We as a nation have had a vast experience of them, and the literature of the subject is enormous, but, withal, little or nothing has been done towards understanding their etiology, or the precise conditions necessary for their existence or production. If we examine the malarial chart of the world, we cannot fail to be struck by the gradation of the disease from the equator to the poles, and by the characteristics of the countries where it prevails. They are, briefly, countries where Nature has her own way, and swamps, jungle, and virgin forests abound. The map suggests a relation of the disease to temperature and water. If we compare the malarial chart of Europe with a physical map of the Continent, the relation of the disease to low land, abundant water, and hot, moist climate, is very evident. Make the same comparison between a physical map of Italy and the map of Senator Torelli, showing the local distribution of the malaria, and the relation of the disease to water, temperature, and altitude of the land becomes a certainty. A study of the local distribution and variation of intensity of malarial fevers in the province of Rome shows us that local conditions have a most important bearing on the subject, and are, therefore, worthy of minute and careful examination, and the general conclusions drawn from the consideration of large areas are still found to apply, and we find the disease to be generally most severe on low-lying ground, in valleys, and in marshy districts.

An examination of the distribution of the population in the province of Rome shows us the usual order of things is reversed, and that whereas in most civilised countries the population is densest in the plain and least dense in the mountains, in the province of Rome exactly the reverse is the case, and we find the mountain population stands to that of the plains in the ratio of 68 to 28 persons per square kilomètre. This starling exception to a well-recognised rule leads us to enquire whether political causes have led to the abandonment of the plain, and the malaria simply stepped in and taken possession, or has the malaria itself been the cause of this abandonment? and, in either case, where did the causes begin to operate?

This is an historical question of the very greatest interest, and also of the very greatest importance to the subject, as tending to show what are the conditions necessary for the development and spread of malarial fevers. There is, however, one very great difficulty in the inquiry, and that is that malaria develops so slowly that, unlike the black death or the sweating sickness, it does not attract the attention of the historian, and thus we are driven to argue its presence or absence, and its intensity, from the history of individual localities.

The one great fact that we have as a starting-point is that in even the later days of the Roman Empire, places now absolutely uninhabitable were not only inhabited but held in high esteem by the Romans as health resorts, so much so that the whole coast line of the province was covered with their villas and country houses, of which we can see the ruins to-day; and we know from the writings of Pliny and others that these villas were maintained in a state of luxury and of magnificence quite incompatible with the presence of such an enemy to health as malaria. There is some evidence, however, that the Pontine district was not all that could be desired, even in those times; and Seneca advises a friend to avoid the neighbourhood of Ardea as not being very healthy. The invasions of the Goths swept away these villas and the high cultivation which surrounded them; the gardens and sacred groves were destroyed, and the population driven to the hills and secure places. Rome itself had sunk almost to insignificance, and the destruction done by the northern barbarians was never repaired, and the Campagna continued the battle-ground of Saracens, Lombards, rival Popes and barons, rendering a return to the ancient civilisation almost hopeless. In the seventh and eighth centuries we hear of fever, not isolated, but widespread, and of serious attempts by various Popes to recolonise and cultivate the desolate country. The so-called Domuscultæ were established, with the double object of military defence and the reclamation of the land, on the site of places which flourished under the Empire—but they do not appear to have been successful, or at most only partially so; and though some of them exist at the present day, for example, the Isola Farnese, the site of the ancient Etruscan city of Veii, they are only aggregations of hovels, and so unhealthy that the population desert them in the summer and autumn.

Thus we see that the Campagna was abandoned from causes purely political, and Nature was allowed her own way in a country where the unceasing toil of man is required to keep her under control. There can be no doubt but that the reckless destruction of trees, which has gone on steadily ever since it was begun by the Goths, has played a most important part in altering the local conditions and local climate of the country; and in comparatively recent times the destruction of timber in the mountains has caused the streams which rise in them to become uncontrollable and destructive, converting large areas of the lowland into bog and swamp, and rendering cultivation difficult and unprofitable.

Our inquiry, therefore, leads us to the conclusion that, from political causes, the local conditions of the Campagna have been most profoundly altered, and that, *pari passû*, malaria has arisen and increased in intensity.

A minute examination of the relation of local conditions to the disease will form the subject of the next lecture.

LECTURE II.

Local Conditions Affecting their Distribution as Studied in the Province of Rome.

In the previous lecture the general relation of malaria to latitude, altitude, water, and climate, have been shown to hold good for a continent, for an individual country, and for a province of that country; it remains to show how far these relations hold for much smaller areas. This involves consideration in detail of localities, and with regard to each the following points demand especial attention:

1. Local conformation of the soil. 2. Constitution of the soil. 3. Water. 4. Altitude. 5. Cultivation. 6. Population. 7. Meteorology. 8. Drinking water.

Local Conformation of the Soil.—The peculiar nature of the Roman Campagna, and the fact that it is by no means a plain, in the generally accepted sense of the word, may be illustrated by the following examples.

The neighbourhood of the Isola Farnese is exceedingly broken up by streams running in valleys with almost precipitous walls, often fifty mètres and more in height, of more undulating country, but still very broken; the neighbourhood of Tre Fontane to the south of Rome affords a good example; here there are valleys whose bottoms are not more than 12 to 16 mètres, and whose sides may rise to 50 and even 60 mètres above sea-level. The streams which flow through these valleys are, for reasons to be considered later, liable to frequent flood, and deposit an enormous amount of mud and silt.

Of true plain, the valley of the Tiber, the Pontine region, and the low land on the coast-line, may be cited as the best examples.

Constitution of the Soil and Water.—It has been shown repeatedly that geology has little to do with malaria, except in so far as it affects the physical nature of the soil. The fact that the greater part of the Roman Campagna is volcanic is of material importance to the subject, inasmuch as it has a great influence on the distribution of the water. Underlying the surface-soil there is frequently an almost impervious layer of littoid tufa, full of saucer-like depressions, which hold water and render the soil with which they are filled and hidden wet and boggy. In some cases these depressions are crater-like and of large size, having once been, to all appearance, volcanic lakes. These larger depressions are found chiefly round the base of the extinct volcanoes of Albano and Bracciano; the best example, perhaps, is that of the Val d'Ariccia, below Albano, which is nearly a mile across, exceedingly fertile, and very unhealthy. After heavy rain the whole valley becomes a bog, there being apparently no adequate means of escape

for the water. This valley is known to have been a lake, and to have been drained in order that the alluvium, which almost filled it, might be cultivated. The volcanic soil holds water like a sponge, and only when it is saturated does the water issue from the hill-sides as springs, and then chiefly because it has met a layer of hard tufa, which stops its downward course. Good examples of this are to be seen near Tre Fontane. Some idea of the water-holding capacity of this volcanic soil may be gathered from the following facts:

In 1876 the water in the torrents in the district of Velletri began to show an increase about October 20th; the total amount of water which had fallen over the drainage-area since the first rains of September was equal to a depth of 25 centimètres, and represented a total of 34 millions of cubic mètres of water.

In 1877 the flow did not begin till even later, namely, in the first fortnight of November, after a rainfall of 17 centimètres, or a total volume of 23 millions of cubic mètres of water. The Travertine area below Tivoli is very interesting as an example of an exceedingly malarious district, covered to a varying depth with a calcareous stone, excellent for building purposes, and on the top of which the soil is often so thin as to render cultivation impossible.

Altitude.—The general fact that malaria diminishes and finally disappears as we ascend is undisputed. The remarkable fact about it is that a very small elevation above a malarious soil affords very efficient protection to the inhabitants. The practice in such countries of building the houses on poles, on the tops of tombs, and similar places is evidence of this; but it would also appear that there is an undoubted difference, as far as the risk of acquiring the disease is concerned, between a house at the bottom of one of the valleys already described and one built on the top of the hills which bound them—a difference in altitude often not more than 30 mètres. The neighbourhood of the Basilica of San Paolo fuori le Mura, to the south of Rome, affords a very curious example of this.

Cultivation.—The ancient cultivation and the present state of the Roman Campagna have been already discussed. The relation of malaria to trees is of great interest, though but little understood. The case of Cisterna will serve as an illustration. In 1714 it was proposed to cut down a large area of *macchia* which lay between the town of Cisterna and the Pontine Marshes. Lancisi, the Papal sanitary adviser at the time, resisted it successfully, on the ground that these trees opposed a barrier or filter to the malarial emanations from the Pontine region; this idea constituting what is known as the "*prejudizio palustre.*" Cisterna at the time was very unhealthy, and had a rapidly-diminishing population. About a hundred years later these woods were cut, and since that time the health of the place has improved, and the population almost trebled.

The attempts made at Tre Fontane to improve the locality by planting eucalypti hardly admit of discussion. The plantations are too small and too young to enable any decided opinion to be formed; still there is considerable evidence that good has been done. We may state generally that the effect of plantations, well kept and of suitable trees, is to drain the soil and distribute the water; while the *macchia* before mentioned near Cisterna, consisting of stunted brushwood, undrained and boggy, was rather a means of collecting stagnant water near the town, and its removal exposed the soil to the light and air, and so without artificial drainage what was practically a bog was got rid of.

Population.—The condition of the moving population of the Roman Campagna is a very serious question; they are ill-fed, ill-clothed, and worse housed, and generally are placed in circumstances

which render successful resistance to the violence of the climate almost an impossibility. Density of population undoubtedly drives away malaria, and we need go no further than Rome itself for a conclusive example. Since the entry of the Italians in 1870 the city has extended enormously, and parts which at that time were something more than unhealthy are now built over, and fast becoming the fashionable quarter. The areas within the walls, particularly on the south, near the Porta San Sebastiano, which are unbuilt on, have a very evil reputation.

Drinking Water.—Is the malarial infection capable of being caused by water? This is a question which is naturally of the very first importance. The evidence, such as it is, would seem to point to an emphatic negative as the answer. The healthiest parts of the city of Rome are supplied by water admittedly the best in the world, and which rises—to take the Acqua di Trevi or Acqua Vergine as an example—on unenclosed land, in springs which bubble up and cover the surface in a locality so unhealthy that to pass several nights there in August might involve risk to life, and certainly to health. There seems to be but little doubt that a supply of good drinking-water is of importance in malarious localities, but it has yet to be shown that, in exchanging pond and ditch water for that of springs, the inhabitants of these places cease to take a poison into their bodies. The evidence points rather to the fact that by so doing they raise their general health, and so become less liable to the disease—at all events, proof that the malarial infection can be conveyed by water is wanting, though very largely credited by the natives of countries where the disease prevails.

Meteorology will be considered in the next lecture in connection with the circumstances under which the disease is acquired.

We may conclude from the facts above quoted, and numberless similar ones which might be quoted did space permit, that the malarial infection is neither wind nor water-borne, that it is extraordinarily local, and dependent upon local conditions for its intensity to an extent not readily believed, and that the local conditions which appear to favour its development are precisely those which affect local climate.

LECTURE III.

Recent Researches into their Etiology and Pathology: The Possibility of Prevention in the Individual, and of Improving the Condition of Malarious Countries.

After considering the general and local distribution of malaria, and the conditions under which it exists, the next question which arises is: How far may the symptoms which characterise the disease be regarded as the natural consequence of exposure of the individual to these conditions? Or is it necessary to go further, and seek their origin in some poison whose growth and development is especially fostered by these conditions?

A simple, uncomplicated attack of malarial fever, as is well known, begins with a "cold stage," often accompanied, but not necessarily, with more or less violent rigors; then follows a "hot stage," or condition of fever, which terminates in profuse sweating, the "sweating stage." It is possible to have such a train of symptoms, to recover, and have no return of them if the patient be promptly treated; but in most cases they repeat themselves at varying but exceedingly regular intervals, constituting what is known as quotidian, tertian, quartan, etc., ague. Further, it is possible for an individual, after an interval of immunity, varying from days to years, to have a recurrence of the symptoms, though not, as a rule, with the same period of intermission, and in old cases the regular intermission disappears.

Further, these symptoms may, and often do, reappear under conditions which render it impossible that there should have been a fresh access of poison, and an individual who has once suffered appears to be more or less liable to returns of the disease as long as he lives, and, should he be attacked by any febrile disorder whatsoever, a distinct intermission will generally be found added, as it were, to the ordinary symptoms of his disease, and this intermission will disappear under the treatment usually prescribed for ague, namely, the use of quinine, arsenic, and the like, in addition to any drugs proper to the treatment of the particular disorder from which he is suffering. If antiperiodics be not administered, the intermission will disappear with the disease, and may not manifest itself again until the patient suffers from some other disease.

Again, in a person who has once had ague, an attack may be provoked by a number of widely different circumstances, for example, fright, surgical injury, nervous and physical exhaustion, sudden chill, and the like; and not only will these circumstances bring about an attack, but some of them are equally efficacious in cutting one short

which has just begun. In the very grave forms of the disease known as "pernicious," the fever is often continuous and frequently fatal. These cases, in the Roman Campagna at all events, are not very common, and in the author's opinion are rarely if ever "first" attacks; and though a first attack may be severe, there is a very large amount of evidence to show that intermittent fever—except, perhaps, in the case of persons of very feeble constitution—cannot be acquired by a few hours' exposure in a malarious locality, and that there is some sort of connection between the duration of the exposure and the severity of the attack; this varies enormously in different individuals, and though it is exceedingly doubtful whether such a thing as absolute immunity exists, there are undoubtedly such differences in susceptibility as to render it at all events conceivable.

The pathological changes in the organs and tissues which accompany the disease are somewhat obscure. In grave cases there is always a large amount of melanæmia, which manifests itself in the liver, spleen, and kidneys, and especially in the cortical substance of the brain, where the capillaries are found to be loaded with minute black granules. The splenic trouble which is characteristic of most cases would seem to point to some special interference with, or alterations in, the functions of that organ; and it is not surprising, therefore, to find in the blood evidence of profound changes in the red corpuscles and their pigment, and the production of certain amœba-like bodies, which, under the name of plasmodium malariæ, have been described by Drs. Celli and Marchiafava as the cause of the disease, the transmissibility of which they claim to have proved by intravenous injection of the blood of a patient suffering from intermittent fever into an individual who was said never to have had it in his life. It is needless to remark that the experiments are open to very grave objections, so grave as to deprive the result of almost all its significance. Dr. W. Osler has given a very full account of these so-called "hæmatozoa of malaria" in the JOURNAL of March 12th. Here it will suffice to state that all attempts to discover an organism capable of producing the disease in the air, soil, or water of malarious localities have signally failed, although a number of organisms have from time to time been announced as such. Nor have the attempts to cultivate the blood of patients produced any better results. The experiments of Professor Silvestrini on the subcutaneous injection of dew, water, and the water in which soil from exceedingly malarious localities had been washed, are interesting. Sixty-three experiments of this kind yielded absolutely negative results; and, despite the large amount of work which has been done in the search for a pathogenic organism, a confirmation of the existence of the peculiar changes in the blood above referred to represents the progress made, and proof that the disease has its origin in such an organism, or that the bodies discovered in the blood come from without, and are not the outcome of changes in the corpuscles themselves, is still wanting.

There is one other theory as to the cause of the disease which claims serious attention. The so-called "chill theory," according to which the thermotaxic nervous system, in endeavouring to adapt itself to the needs of the body, exposed to the great and violent changes of temperature said to occur in malarious countries, breaks down and becomes disorganised; that is to say, malarial fever is essentially a disease of the nervous system caused by exposure to climatic conditions. Chill is probably a wrong term to use, for the breakdown is more likely to be occasioned by exposure to excessive heat than to excessive cold; and considering that we know practically nothing of what occurs in the body when exposed to a temperature above its own, the theory cannot be summarily rejected. It depends, however,

on the supposed existence of these violent changes which have not apparently been made the subject of accurate observation by those who have urged this explanation of the disease. From a large number of experiments made by the author in exceedingly unhealthy sites near Rome in the summer of 1885, it would appear (1) that the daily range of temperature in these places is very great; (2) that the changes are sudden and violent; (3) that the characters of the curves indicating temperature and tension of aqueous vapour present in the atmosphere present most marked differences in localities barely 200 mètres apart horizontally; similarly marked differences are found in the records of instruments placed at different vertical heights above the soil; (4) the connection between these variations of temperature and vapour tension and the malarious character of the localities in which they were observed is such as to lead to the conclusion that if not in themselves the cause of the disease, they must directly affect any organism to which such a power could be attributed, and it would seem fair to conclude that if these climatic conditions could be modified, the pathogenic organism which may be supposed to thrive under them would disappear, and the localities in question become healthy. Either as sufficient cause in themselves, or as controlling the growth of organisms, these phenomena undoubtedly have a most intimate connection with the disease, and it becomes possible for us to understand the real value of the precautions universally deemed advisable in malarious countries—fire, food and clothing, the avoidance of low, damp ground for camps, the building of huts on poles, residence in the top floors of houses and the like. It is difficult to realise from mere figures what these climatic phenomena really mean, but one night spent in the Campagna in August would probably suffice to convince the most sceptical of the necessity of protecting the body against them, and to realise the wretched condition of the greak bulk of those who are most exposed. Ill-fed and worse clothed, they have to resist, all day long, a temperature often 104° F. in the shade, and to sleep in a damp, wretched hovel in an atmosphere saturated with moisture and a temperature which just before dawn may have fallen to 38° or even 36°, to rise in three or four hours to 100° or more. A healthy person exposed for some time in places where these conditions obtain runs grave risk of acquiring an intermittent fever; and one who has already had the disease will readily relapse under them, and may be attacked by one of the very grave forms; in both cases the result may be attributed to access of poison. But the same explanation will hardly hold in cases of relapse from exposure to heat or cold in a non-malarious country, and after years of immunity. Either the organism, if such there be, has a wonderful power of lying dormant, and of being recalled to activity by exceedingly diverse conditions, or the thermotaxic nervous system, having once been thrown out of gear, readily breaks down again under strain.

The recurrence of attacks would seem to be, as it were, a vice rendered the more easy by practice; consequently the anticipation of them by drugs or other remedies is of great importance in treatment. Chronic cases, in which all regular periodicity has been lost, are notoriously obstinate and difficult, if not almost impossible, of cure; much may, however, be done in all cases by avoiding exposure to the above-mentioned extreme variations of temperature and the maintenance of "tone" in the nervous system.

The question of the cure of a malarious country resolves itself into the removal of the causes of these climatic extremes, and this in turn into perfect control over subsoil water. Drainage and the planting of suitable trees are the well-recognised methods of effecting this, and

the care bestowed by the Romans on their woods, and the elaborate system of drainage which they constructed in the hills round Rome, would seem to indicate that they at all events realised the vast importance of these things.

It is very evident from the facts that malarial fevers have a most intimate relation to the soil and to local climate. In the case of the Roman Campagna, it has been possible to some extent to trace the spread and increase of the disease *pari passu* with the depopulation and neglect of the soil; and whether malaria be due to the direct influence of climatic conditions on the individual, or to a pathogenic organism, there can be no reasonable doubt that these peculiar local conditions form an important factor in the problem of its causation; and not only of malaria, but probably of other diseases. The peculiar form of enteritis known as typho-malaria exhibits a similar relationship to the soil, and in England infantile diarrhœa shows a connection hardly less striking.

Our knowledge of the relations of soil and climate to disease is scanty and very general, and a careful study of these local conditions would probably tend to throw great light on much regarding them which is at present obscure or almost inexplicable.

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