REMARKS

ON

THE EPIDEMIOLOGY AND PROPHYLAXIS OF
MALARIA IN THE LIGHT OF RECENT
RESEARCHES.

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At this prolific time, when in various parts of the world malaria is occupying the attention of many eminent men of science who frequently are not aware of, or at least do not mention, what the others have said on the question, I deem it advisable briefly to summarise what I have stated with regard to the new epidemiology and prophylaxis of this disease in my book published on July 15th, 1899,¹ and have further discussed in successive publications—one on September 1st,² the other in the same month.³ To these I would refer those who desire to know the details and the history of the several etiological and epidemiological questions, stating once for all that I shall follow principally what—following the remarkable discovery of Ross in the life of the malarial parasites in the body of the mosquito—the Italian Society for the Study of Malaria has done, especially through the work of Grassi, Celli, Bastianelli, Bignami, Dionisi, Casagrandi, Santori, during the past eighteen months.

EPIDEMIOLOGY OF MALARIA.

A. Sources of Infection.

Man is the temporary host, and the mosquito the definitive host, of the malarial parasite. These parasites complete their asexual life and prepare their sexual forms in the human blood, while they complete the sexual cycle of life, that by which the species of the parasites external to man is assured, in the middle intestine of the mosquitos.

It follows, therefore, that man and mosquitos are the sources of malarial infection which circulates, so to speak, from man to mosquito and from mosquito to man, and so on. In this circulation of the contagion the presence of malarial man is indispensable, inasmuch as down to the present time the hereditary transmission of malaria from mosquito to mosquito has not been demonstrated experimentally or morphologically, nor have resisting parasitic forms been found in the environment external to the body of the mosquitos. Malaria is, therefore, a typical contagious disease.

Where there is malaria mosquitos abound, but malaria does not exist in every place where mosquitos abound. This is explained by the fact that in malarious regions particular species of mosquitos live (Grassi). Those capable of lodging the specific parasites and of infecting man appertain to the genus *Anopheles*. All the four species (*A. claviger* or *maculipennis*, *A. bifurcatus*, *A. superpictus*, and *A. pseudopictus*) of this genus which exist in Italy are injurious. It is not probable that the species of *Culex*, or other blood-sucking insects, which are found in malarious places, can also transmit malaria. Consequently all the palustral mosquitos are not malarial. And since, as far as is at present definitely known, the specific germs external to man live not in the soil, but in the body of the mosquito, it follows that malaria can no longer be cited as a classic example of a disease of the soil. The soil plays only a secondary indirect part, in so far as it is favourable or not to the life and development of the malarigenous mosquitos. The same may be said of water. It may be, and in fact is, the habitat of the eggs, larvæ, and nymphæ of the mosquitos, which eventually become malarigenous. Therefore soil and water pass into the number of the indirect epidemic causes, that is to say, those which we term predisposing or immunising.

B. Life of the Malarial Germs in the Environment.

These mosquitos of the genus *Anopheles* lay their eggs in sequestered places in clear, slowly running or stagnant waters, where the eggs and larvæ of the genus *Culex* are rarely if ever found. In general the so-called ground waters that appear at the surface and run slowly (trenches, canals, etc.), or are

slowly renewed (lakes, ponds), contain the best *pabulum vite* for the larvæ of the *Anopheles*.

These waters, which freely nourish the so-called marshy vegetation, are relatively cool in summer and warm in winter, and consequently the larvæ live very well in them in certain climates throughout even the whole year.

The resistance of the immature forms to natural physico-chemical agents varies; the larvæ offer slight resistance to desiccation, the nymphæ much resistance; freezing, especially if the ice be continuous, is injurious, as is also putrefaction after a time. In sea water, and still more in saline waters and in very strong sulphurous water, they cannot live. Movement of water, if beyond a certain velocity, is also hostile to them.

In Italy the mosquito season, that is the season in which the perfect insects develop up to ovivification, extends from the first warm days of spring to the first cold days of autumn or winter, and has its maximum in the hot months. The new mosquitos begin to bite man towards the second half of June and continue to do so till they hibernate. Three of the four species of *Anopheles* are very domestic insects which pass much of their life within or near human habitations; malaria, therefore, formerly considered a typical miasmatic disease must now be considered as a rule one of the domestic epidemics.

C. Carriers of Malarial Infection.

Popular experience in Italy has given a name to this disease which has been universally adopted, and which tells us that the vehicle is the air. As to the mode of this propagation the following axioms may be stated:

(a) The hours in which the infective agents are most plentiful in the atmosphere are those of the evening, sunset, and night.

(b) These agents rise from limited foci and spread to a limited distance in the horizontal, oblique, and vertical directions.

(c) The winds do not transport these agents; on the contrary, they tend to diminish their amount in the atmosphere.

(d) Woods, instead of filtering the malarial agents may be foci of this infection.

These axioms are strictly connected with the new theory that the malarial germ is cultivated, carried, and inoculated through the agency of mosquitos.

1. By day these insects lie hidden and sequestered, while they issue forth in the evening and night to bite man.

2. They do not fly far from the spot where they are born, and in particular do not fly to a considerable height in the air.

3. When the wind blows they do not generally leave their hiding places.

4. Shady or damp woods and trees in general are the homes of mosquitos. The mosquito, therefore, besides being the source, is also the carrier of malarial infection. Of all the vehicles of infection of malaria hitherto suggested, the mosquito is the only one which has yet been directly and undoubtedly demonstrated.

Water, for example, is not the vehicle of malarial infection. The data of epidemiology prove this, and a long series of direct experiments confirm it. We may likewise exclude the suggestion that the malarial infective agent lives directly in the soil, and consequently the theory that it is breathed with the dust raised from it cannot be accepted.

Neither can the theory that the alimentary substances used in malarious places are the vehicle be accepted. Therefore, the undoubted carrier, and at the same time the source of malarial infection, are special mosquitos, and the air is the carrier of malaria, inasmuch as it is the vehicle of the malarial mosquitos.

D. Path of Penetration of the Malarial Germs into the Organism.

The only indisputable path by which the infective agent penetrates is that of the skin bitten by the proboscis through which the infected mosquito inoculates its sporozoites. The same mosquito in a single night may bite and infect many persons.

The biting apparatus is so powerful that it can penetrate a very tough skin, and bite through fairly thick clothing. It is remarkable also that the *Anopheles* mosquitos do not make

the humming sound and are not so annoying as the *Culex*, so that very frequently people are not aware of their presence or of having been bitten by them. There is nothing to prove that the specific germs penetrate by way of the stomach, and the results of recent investigations make it necessary to exclude the respiratory path also, at least until it has been demonstrated that resisting spores of the hæmosporidia live free in the environment.

E. Causes of Predisposition and of Immunity.

No epidemic can be thoroughly understood unless the enormous importance of the indirect causes, that is to say, the causes which are favourable or inimical to the development of an epidemic are recognised to the full. These very complex causes I divide into organic or individual, physical or local, and social.

1. Organic Causes of Predisposition of Immunity.

It is generally admitted that chilling of the body predisposes both to the onset of the primary infection and to relapses. It is equally certain that children are most attacked, and that in Italy the highest mortality from malaria occurs in individuals between 5 and 30 years of age.

Concerning immunity from malarial infection it may at present be stated that no race, not even the black, has *per se* a congenital or hereditary immunity against malaria, nevertheless both the black and the white races may become more or less adapted to resist it. This is sometimes brought about, in part at least, by the habits of life, which by traditional experience has wisely been directed against malaria. There are, however, even in regions where malaria is very severe, individuals who are naturally immune; and this immunity in some seems hereditary, in all it does not depend on their habits of life. On the contrary, it persists in spite of ill-usage, excessive work, insufficient food, the bites of mosquitos very probably malarial, and even, in some cases, in spite of repeated inoculations of malarial blood. It must therefore be a true and proper organic immunity.

There is also an immunity due to malaria suffered, and which is generally a result of malarial cachexia, rarely after an infection of not long duration; it is independent of treatment with or without quinine, and is always less stable and durable than congenital immunity. Neither the mechanism of this immunity, nor the genesis of the fever, of its deferescence, and of its spontaneous cure can be explained by the principles of serumtherapy.

Artificial immunity against experimental malaria cannot be produced, either by the morbid products of the malaria of the lower animals, or with the serum of the blood or the organic juices of animals immune to their malaria. On the other hand, it can be produced by drugs. Potassium iodide and bromide, carbolic acid, antipyrin, phenocol, and arsenic have given negative or uncertain results; euehchin, on the other hand, has prevented mild quartan and tertian fevers, and medicinal methylene blue severe tertian, even after enormous doses of blood loaded with parasites (1-2 grams of blood) have been inoculated. It is probable that the same can be said for the natural infection.

2. Physical or Local Causes of Predisposition or of Immunity. *Conditions of Place.*

Soil.—There is no quality of soil which can be said *a priori* to be incapable of favouring the development of malaria, inasmuch as in this sense the soil does not act *per se*, but only so far as it is or may become a reservoir of water.

Water.—This is necessary for the development of malaria, inasmuch as it is necessary to the life of the larvæ of the malarial mosquitos.

The waters in which they prefer to live or live exclusively have already been described, and it has been pointed out that all mosquitos are not malarial. Thus the new investigations confirm the fact that neither extensive marshes with their effluvia, nor the putrefaction of waters, nor the mixture of fresh with salt waters are conditions indispensable for the production of malaria. These may to a certain extent be conditions which do not obstruct the life of the related mosquitos, and, consequently, the development of malaria. The true essential condition is that the ground water appears on the surface of the soil, even though its area is small, and

then remains stagnant or runs very slowly. The Roman Campagna teaches and demonstrates this in an indisputable way.

Air.—This also is indispensable to the existence of the malarial organisms in the environment, inasmuch as it is indispensable to the life of the larvæ and nymphæ in water. Any kind of soil is capable of becoming malarious when the water and the air and certain conditions of vegetation, which will be mentioned presently, combine to enable the malarial mosquito to live there.

Agriculture and Malaria.

It can now no longer be admitted that the simple stirring up of the soil in malarious places determines the liberation of the germs of this infection. On the other hand, any movement which in any way alters the hydraulic conditions of a given area may really become a local cause predisposing to the development of malaria.

Marshy vegetation, composed of canes, rushes, water lilies, cresses, and *Confervæ*, is very favourable to the life of the larvæ, and is, therefore, also favourable to and a concomitant of malaria. Irrigation may favour the development of malaria by favouring the existence of the larvæ of *Anopheles*. Thus irrigated meadow lands in malarious places, whenever the water becomes quite or almost stagnant in the afferent or efferent channels, and still more rice fields, with their clear and almost still water and typical palustral vegetation, constitute the best habitat of these larvæ. Hence, as is known, the formation of rice fields causes the reappearance of malaria where it had become extinct, and where it already exists they are a very active focus of production.

The maceration of textile plants has been considered as supplying another active focus. During maceration, however, the waters while they are the cradle of the larvæ of *Culex* are the grave of the *Anopheles*; it is probable, therefore that the dread they have inspired as a source of malaria is the effect of the belief in the putrido-palustral theory as a cause of disease in general, and of malaria in particular, which has so long dominated medical schools.

Aboriculture of a malarious territory is favourable to the development of malaria. The old epidemiology had already proved this. The new etiology teaches us that some mosquitos prefer to sojourn in shady woods rather than in any other place; and amongst these wood lovers is the *Anopheles bifurcatus*, which lives preferably in woods, so that a person sleeping in them by day, and, speaking generally, sleeping under trees in malarious places, very readily takes the fevers in the season when they prevail. At the present day we know of no plant inimical to malaria—that is to say, to the mosquitos—though the eucalyptus, the coniferæ, and the ricinus communis have been the subjects of groundless praise on this score. Among the many odoriferous plants only a single species of wormwood has the power of killing mosquitos when it is in flower, and this only in a closed chamber. High cultivation may partly correct the local predisposition to malaria, but it does not destroy it, because the larvæ of the *Anopheles* are found in streams of clear, slowly-running water under the conditions already described.

Other Industries and Malaria.

Fish ponds of fresh or slightly salt water near the sea coast are, as is known, sources of malaria; on the other hand, saline waters and sea water in various degrees of concentration are never places where the larvæ of the *Anopheles* flourish. Peat bogs instead, with their pools of ground water and their rank vegetation, offer the most favourable local conditions for the production of mosquitos, and consequently of malaria. Frequently, also, the railways in Italy are fomites of malaria, either because they alter the hydraulic conditions of a district, or owing to the excavation of the so-called borrowing pits (pits from which soil is obtained for making embankments) with a deep bottom and without discharge, so much used and abused by railway constructors.

Influence of Season.

That these have an influence on the production of malaria has long been known, so that the malarial fevers are named after the seasons. The statistics of about 93,000 cases of malaria admitted during thirteen years into the hospitals of

Rome appear at first sight to show that malaria is endemic during the whole year. With some oscillations, however, it always remains in the first six months relatively low, with the maximum in January, the minimum in June; in the first or second decade of July there is a sudden change; the true epidemic bursts forth. Its maximum generally occurs in August, sometimes in September, and even in October.

Nevertheless, in order to exactly follow the annual course of malaria it is necessary to distinguish carefully the primary forms from the recurrences, and the three principal forms of malarial fevers—the spring and quartan, tertian, and summer tertian. It is then seen that the true malarial season—that is, the season of primary infections—is in the second six months of the year. Its sequels with the recurrent fevers are prolonged through all the first six months of the following year, gradually declining from January to June. The fevers, therefore, of the first half of the year are generally recurrences of the infections contracted in the second half of the preceding year. By means of these recurrences the seed of contagion is maintained. In the summer season it is transmitted by the agency of the mosquitos, and opens the subsequent epidemic year. The epidemic year of malaria extends, therefore, from the July of one year to the June of the following year. It is remarkable that the quartan is the last to appear, and also the last to recur; the mild tertian, and the severe, have a similar but not identical annual course, the second, in summer and autumn, notably prevailing over the first; hence the name *æstivo-autumnal tertian*. This tertian is the first to cease recurring, and consequently in the spring mild tertian and quartan prevail, and have therefore *a fortiori* been called spring fevers.

The life of the *Anopheles* is in direct and intimate relation with the annual epidemic course of malarial fevers. The new generations begin to bite in the second half of June, and in the first half of July. Toward the end of June the first infected mosquitos are observed, and their number increases in July and August.

Therefore it is now more than ever necessary thoroughly to study in malarious districts the season of the malarial mosquitos, and to investigate the course and the oscillations of the disease. The ultimate cause of the periodic course of this epidemic, and of its different annual course in various climates will thus be explained.

It is equally necessary to study the relations between the weather and malaria. These relations are not yet clearly defined. We can say, however, in a general way, that a temperature of from 20° to 30° C. is necessary for the development of the hæmosporidia in the body of the mosquito (for those of the quartan a lower temperature is perhaps sufficient, hence the later appearance of this infection). Certainly the temperature influences the sudden appearance of the fevers in July, and their prolongation in the autumn and sometimes to the beginning of winter if cold weather set in late.

In the same way the difference of temperature between the day and night, so characteristic of malarious places, must produce that predisposing cause termed above chilling of the body; and the winter colds and frosts also perhaps concur in regulating the annual quantity of the mosquitos, and therefore also of malaria.

Relations have likewise been asserted to exist between the rains and malaria, that is to say, a heavy rainfall in the spring is said to be followed by much malaria in the summer, and *vice versa*, and the heavy showers of the summer are also said to be followed by the sudden appearance of the fevers. The constancy and the certainty of these relations are, however, now seen to be doubtful. No relation can be shown between the winds and malaria, nor between fogs and malaria.

All these relations between meteorological conditions and malaria, however, need to be better studied and brought into concord with the new etiological researches.

3. Social Causes of Predisposition or of Immunity.

Unfortunately on the human race still weighs that fate by which avoidable diseases and the duration of life essentially depend on economic conditions. I will therefore analyse briefly the social and economic causes of predisposition and immunity to malaria—food, housing, clothing, work, education.

Alimentation.—The food of our poor peasants for almost all the year consists chiefly of maize with a deficiency of nitrogenous and an excess of triple substances. The effect in nitrogenous constituents manifests itself in the inevitable and enduring physical deterioration which causes the starved appearance of our rural labourer, and his predisposition to malaria. Wheat bread he eats only during the period of excessive work in summer, and not always then. This poor pariah, who works infinitely more for others than for himself, is frequently the slave of masters not always humane or disposed to give him sound maize, and almost always the slave of the so-called *caporali* (foremen), who rob him with impunity of his wage and food, or give him the latter damaged.

Housing.—As we have said very often malaria is a domestic epidemic. The enormous importance of this social factor is therefore evident. The most common type of habitation of the peasantry in our malarious places is the reed hut—a true habitation of primitive man. There is nothing good about such a hut except the smoke given off by the fire in the middle of the floor, which drives away the mosquitos. Some of these people sleep in caves, and in summer, during the period of heavy work, the greater number sleep in the open air. The houses, besides being scarce, are generally constructed without regard to the prophylactic rules against malaria, except that they are frequently built on high ground. Thus in the low-lying malarious places the population have for centuries taken refuge on the neighbouring hills and mountains, and along the ancient roads one frequently sees mediæval cottages built on ancient monuments.

Clothing.—The clothing of all the miserable peasantry of the Roman Campagna is, for the most part, very insufficient, either to prevent chills or to protect them from the bites of insects. The children especially, who swarm in the huts, are during the whole year more naked than clothed, and it is they who pay the heaviest tribute to malaria.

Work.—In the seasons when there is much agricultural work to do casual labourers come in crowds from the neighbouring provinces. Those who come in May or June for the haymaking never or hardly ever bring the fevers with them. Of those who come at the end of June for the reaping, some contract fevers, while of those who remain in July and August for the threshing the greater part, in some years or places even all, fall ill with the fevers. Work, excessive either in intensity or duration, readily leads to the recurrence of the fevers; sleeping in the open air exposes the workers to the bites of the mosquitos, and so to infection. The enormous difference between the day and night temperatures is also an organic predisposing cause. The importance of agricultural work in determining the appearance of the epidemic in July and its great prevalence in August is thus readily understood.

Education.—When through poverty this is wanting all the most baneful prejudices as to the sources and vehicles of the infection, and also as to the means of protection, arise and flourish. Fortunately traditional experience in malarious places has taught many useful prophylactic rules, and nowadays the old prejudices against the specific remedy, quinine, and the mode of taking it have almost disappeared.

PROPHYLAXIS OF MALARIA: MEANS DIRECTED AGAINST THE INFECTIVE CAUSE.

A. For Destroying the Malarial Germs.

1. Verification of the Diagnosis.

As is usually the case, rational prophylaxis depends on accurate diagnosis, and in this case what is necessary in order to verify the diagnosis is to examine the blood either in fresh or stained preparations. To make an examination of fresh blood the lobule of the ear is pricked with a needle in order to avoid pain, and the stratum is made so thin that by pressing with a handkerchief the cover-slip against the slide the red corpuscles, though close to one another, are not superimposed, and the superabundant blood is removed. This examination, made by an experienced person, enables him not only to verify the diagnosis of malaria, but also to determine its clinical variety and the stage of the febrile period, that is, whether the paroxysm is about to begin or is at an end, and to do this with so much precision that with the microscope he can frequently correct the anamnesis of the patient. This examination is also useful in making the prognosis, and for the treatment especially in severe cases of pernicious fever.

When the blood cannot be examined microscopically within half an hour after it is obtained, dry preparations of it must be made with suitable stains. The blood is allowed to spread itself out between two cover glasses in a very thin stratum, and is fixed by placing the slips for 15 or 20 minutes in absolute alcohol. The staining is done by the Tiemann-Romannowsky method.¹

A.—A saturated watery solution of very pure medicinal methylene blue (Meister Lucius) at 25° to 30° C. for 3 days.

B.—An aqueous solution 1 per cent. of eosin A, G, or B (Meister Lucius).

Take of A parts 1 to 3
 " B 3 to 5 and mix.

This mixture " must act on the preparations for from 20 to 30 minutes.

The red corpuscle is stained (pink) by the eosin; the hæmosporidium by the methylene blue, and its chromatic substance is coloured purple by a third stain formed by the above mixture.

2. Isolation.

This is the first prophylactic measure, and should be taken directly the diagnosis is verified. In a malarious place a person affected by the fever is very dangerous to others, and should therefore be isolated, malaria being a true and proper contagious disease. To the patient one must give the order *tuge eolum in quo ægotasti* as much for himself as for others; for himself because in an unhealthy place he is always liable to be bitten by infected mosquitoes and frequently therefore to mixed infections, that is, to contemporaneous infection by various malarial parasites; for others because he with his sexual parasitic forms is the source of infection of the mosquitoes, and consequently of man.

Malarial patients can be isolated in any place where there are no malarial mosquitoes. If later on, as is to be hoped, a mode of using substances to prevent the biting of mosquitoes be discovered, it will be possible to isolate without removing the patient; for example, by the application of an inhibiting stratum, so to speak, on the uncovered parts of the body, of any substance which drives away mosquitoes.

The best place for isolation, however, would be special sanatoria situated in healthy elevated regions. Inasmuch as the sexual forms of the parasite are the most dangerous sources of contagion, and they unfortunately remain for a long time in the blood, the convalescents should not be sent back to the infected places until the absence of the parasitic forms most dangerous socially has been verified by repeated examinations of the blood and perhaps also of the spleen.

3. Disinfection.

Disinfection must be directed against the sources and against the carriers of the infection.

Destruction of the Blood.—Quinine, as is well known, is the specific disinfectant for amoeboid organisms, and consequently for the malarial parasites in their amoeboid stage. It is better, therefore, when possible, to give it after the paroxysm, when the hæmosporidia are young and amoeboid within the red corpuscles. Unfortunately, however, quinine does not act on the parasitic forms which prepare the recurrences, nor on the gametes which ensure the sexual cycle in the mosquito. Consequently, it is not easy to obtain a thorough sterilisation of the blood. The quinine must be given at once at the beginning of the fever and in large doses, 2 grams, for example; it should be repeated in doses of 1-2 grams for several days, and then at intervals of five, six, or seven days. But even this treatment, if the patient remain in the infected place, does not always prevent recurrences, and an intolerance for a drug which disturbs the stomach and nervous system so much is easily produced. In all these cases, which are unfortunately very frequent, it is a mistake to believe that the treatment by means of quinine is sufficient to ensure the complete prophylaxis of malaria, and to cause it to disappear from the face of the earth.

Destruction of the Source and Carrier of Infection, that is of the Malarial Mosquito.—This problem practically consists in destroying the larvæ in the water and the mosquitoes in the air. For the destruction of the larvæ and consequently for the disinfection of the waters which contain them, vegetable powders (unexpanded flowers of Dalmatian chrysanthemums)

certain aniline dyes (larvicide of the house of Weiler-Ter-Mer of Uerdigen) and petroleum are the best, taking into consideration the dose, practicability, and price. By cultivating chrysanthemums on a large scale it is very probable that the malarious place itself will produce that which will rid it of the mosquitoes which infest it. Larvicide acts even in the small dose of 0.00031 per cent., and its cost per c.cm. of water may be as low as lire 0.0056 to 0.0012; it is very diffusible, remains active for a long time in water, and is not poisonous to plants nor to animals. Petroleum, which acts mechanically by asphyxiating the larvæ and nymphæ, must form a stratum which covers the whole surface in the proportion at least of 0.20 to 0.10 c.cm. per 100 c.cm.; it has the defect of evaporating and therefore its action is of short duration. The selection of one or other of these means will depend upon circumstances. It should be remembered, however, that the most suitable time for destroying the larvæ is the winter or the beginning of the spring, when they are in least number in the waters, and when the new generations have not yet made their appearance. The knowledge of the place and the season in which they nest will very much aid this destruction, which on a large scale will never be very easy, and it will be difficult as long as the health of man who suffers from malaria is not protected. Still, after the efforts that have been made by nations and private individuals to protect vines from the oidium, peronospera, and phylloxera, surely something should be done to save the life of man from malaria. In any case, it is necessary to insist on the destruction, especially in the winter, of the aerial mosquitoes in houses wherever they hibernate, inasmuch as the death of each mosquito means the non-appearance of from 200 million to 20 milliard descendants the subsequent season, the former number being produced by four generations in a season, and the latter, as frequently happens, by five (Ficalbi). The destruction of the aerial mosquitoes inside houses in the malarious months is also a valuable prophylactic measure. For this purpose the fumes given off by an ignited powder composed of the unexpanded flowers of chrysanthemums, valerian root, and larvicide is the best of all the odours and all the fumes tested and retested in the laboratory and on a large scale. It is sold by the Italian "Chémico"-Pharmaceutical Society of Rome under the name of zanzolin. Consequently the problem of the destruction of mosquitoes as a means of antimalarial disinfection can and ought to be brought into practice.

B. For Impeding the Penetration of the Malarial Germs.

Numerous prophylactic means have been used for this purpose, some long prescribed by popular experience; they are:

Habits of life, such as not sleeping in the open air, not leaving the house from sunset to sunrise, or, better, living when possible in a healthy place during these hours; not keeping a light in the room with the windows open and unprotected.

Mechanical means, such as clothing. For those who have to be out at night a mask to cover the face and neck, such as is used by bee-masters, and gloves. A close network for windows and doors of houses, a mosquito net for the beds, and, when electricity can be obtained, electric ventilators.

Chemico-mechanical means, such as culicifugal perfumes for the person and of the dress, culicifugal washes, pomades and soaps; among the most efficacious odours are essential oil of turpentine, iodoform, and menthol; a pomade of valerianic acid also acts well, but its smell is objectionable; soaps made with extracts of tobacco and with turpentine act fairly well. The latter soap is more useful, more practical, and cleaner. It has been used in some of the signalmen's houses along the railways; the men soap the face and other uncovered parts of the body with it; on returning to their homes after work they wash it off, and it cleanses the skin like ordinary soap. This soap prevents the mosquitoes biting a person in the open air for one or two hours. All the other odours have no effect in the open air, and in closed rooms they must saturate the air.

MEANS DIRECTED AGAINST THE PREDISPOSING CAUSES.

1. Against the Organic Predisposing Causes.

Clothing again makes its appearance as a prophylactic

means, inasmuch as it protects the body from chills, which may be a cause of predisposition.

For obtaining artificial immunity most is at present to be hoped from methylene blue. I am now experimenting with it on a large scale. Arsenic as a prophylactic has on a large scale given uncertain results.

2. Against the Local Predisposing Cause.

If man can do nothing against the local predisposing conditions of time he can do much against the local predisposing conditions of place. Among these it is necessary to remove and lessen the principal predisposing causes, which are stagnant or almost stagnant water and the air.

To correct the first of these causes of predisposition it is necessary to provide for the systemisation of the superficial water (rivers, lakes, ponds) and the ground water. To correct the second there are coverings with healthy soils, and eventually also with water.

The length of this article does not permit me to enter into particulars of these various means of hydraulic sanitation. We can, however, on the basis of modern researches form an opinion as to its effects.

The essential condition in any scheme for the sanitary improvement of a malarious place is that it should prevent the eggs, larvæ, and nymphæ living in that place. Covering with healthy soil and the drainage of the ground water, inasmuch as they remove at the same time both the water and the atmospheric air, the two indispensable elements of life, are the best modes of destruction of mosquitos, and in fact are also the best and most infallible systems of hydraulic sanitation.

All the other systems with surface and open channels, or with water that remains on the surface, will be efficacious in proportion to the velocity of the water, for the eggs and larvæ can live only in water which is moving slowly. It is in fact known that the hygienic results of these hydraulic improvements are under different circumstances and in various places good, mediocre, or *nil*. The biology of the malarial mosquitos affords an explanation of this, as we know the rate of velocity of the waters incompatible with the presence of these mosquitos.

Any of these systems of hydraulic sanitation, however, must be associated with agricultural improvements, such as levelling of the soil, ploughing, etc., which are indispensable complements of the most extensive works of hydraulic sanitation. The local predisposing conditions will undergo change according to the system of cultivation adopted.

Naturally, dry cultivation is the best against the mosquitos, and consequently against malaria, but unfortunately it is not remunerative. Nevertheless, even high cultivation has sometimes attenuated, sometimes suspended, and sometimes perhaps even suppressed the production of malaria. Everything depends on this, that the clear and stagnant or almost stagnant spring waters which as we have repeatedly seen are the habitat of the malarial mosquitos, are not left uncovered even in narrow channels as one sees them in the market gardens round Rome.

In malarial places the irrigation of meadow lands should not be recommended, or at least it should be conducted under certain rules, so that the water does not become stagnant in the channels, which should have a sufficient fall and section to allow the water to run alternately in the various channels in such a way as to prevent the growth of marsh vegetation and to sweep away the eggs and larvæ deposited there.

Until a cheap larvicidal substance which is not injurious to the growth of the rice plants is found, ricefields should on no account be permitted in severely malarious districts.

The planting of trees in malarial places is injurious for the reasons already given; and in fact in many places disforestation has been or would be a true hygienic improvement.

Urban Sanitation against Malaria.—It is very easy to immunise a town against malaria. This has been done in Rome, from the epoch of the kings, and afterwards during the Renaissance by conveying away the surface water in a system of sewers, which were later on used for the true and proper sewage; by the paving and covering of the streets the air has also been subtracted; with the walls the entrance of insects from outside has to a certain extent been prevented;

and therefore one understands how this city remains perfectly healthy in the midst of a pestilential territory.

Moreover a town may be healthy even in a malarious district if it be built at an elevation which the insects from the plain do not reach. This is the case in the villages and small towns in the province of Rome.

Sanitation of Malarious Industries (fish ponds, peat bogs, railways, salines).—The sanitation of fish ponds will become possible when a very cheap culicidal substance not injurious to fish is found; the sanitation of peat bogs can be carried out by means of pumping machines, or by putting the water of the pits in motion. For saline waters no sanitation is necessary; on the contrary, sea water may be utilised for the sanitation of the neighbouring fresh waters when they are fomites of malaria. There is much to be done, on the other hand, for the sanitation of railways so constructed as to cause the reappearance or increase of malaria, and the drawbacks already mentioned should in the future be avoided as much as possible in the construction of railways in malarious districts.

3. Against the Social Predisposing Causes.

The removal of the terrible causes of epidemic predisposition, that is, the improvement of the clothing, housing, labour and education of the workers in malarious places is a task for social reformers and the Legislature.

The Romans in their best epoch regulated with much equity and wisdom the treatment in respect to feeding, clothing, and housing of the slaves who worked in the Campagna. Even in the Middle Ages the provisions made with this object were much better than they now are; for 300 years the daily wage of the workers has remained the same, if, indeed, it has not been diminished, and the habitations have certainly not been increased or improved.

Among us there is much to be done to prevent the organised spoliation of the peasants. It is necessary to reform and amplify the laws as to labour in malarious places, to reform completely the law on the cultivation of rice (June 12th, 1866), to modify the laws on agrarian sanitation in general and of the Agro Romano in particular, and to regulate by new laws the colonisation of unhealthy places.

For example, the reclaiming of malarious places should be regulated in such a way that prophylactic rules be precisely established in relation to the most healthy seasons and hours, the habitations, and the selection of the workers. These should be selected from families most habituated and resistant to malaria, and by means of examination of the blood those infected, and therefore dangerous to the others, should be immediately eliminated.

The workshop should be situated in the most healthy spot, and the land around it rendered healthy. A minimum wage should be established, and should be convertible into food and clothing without the intervention of middle men. The cases of fever contracted in service should be included in the cases of misfortune through work, and the patients sent to healthy places till their health is completely re-established. This would also be a useful general prophylactic disposition. Schemes of colonisation with people from healthy districts should be prohibited, unless hydraulic sanitation has preceded, inasmuch as a colony of people transported directly from a healthy region to a very pestilential one could not endure it.

Unfortunately, however, all this social prophylaxis against malaria is very difficult to carry out, and will be so as long as capital impoverishes with impunity the life and health of man, and private property remains the greatest enemy of public hygiene.

Finally, a word must be said on education as a prophylactic measure against malaria. It is certain that when of this, as of every other preventable disease, the sources of infection, the life of the infective germs in the environment, the vehicles, the mode of penetration, and the various prophylactic means are generally known much will have been done.

It is clear, therefore, that the diffusion by means of education of the facts of the new epidemiology and prophylaxis, the combating of the old prejudices will be so many preventive measures directed against this scourge, which it is necessary to combat by every means. Certainly the individual prophylaxis of malaria is very often practicable and efficacious, nevertheless, the popular prophylaxis of a whole working

population of a whole region is always an arduous undertaking, and one must not place confidence, after what we have said, in those who believe that this scourge, so old and so diffused, can be curbed by one only of the many means I have mentioned. In the future, if and when a mode of immunising man even in countries where malaria is severe is found, then the task will be much simplified.

At present to him who asks us how public prophylaxis is to be effected in a complete manner, we can reply by indicating the means above described, and adding *unum facere et alterum non omittere*.

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THE SALINE TREATMENT OF DYSENTERY :

WITH NOTES OF 555 CONSECUTIVE CASES WITH 6 DEATHS.

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In an article published in December, 1898,¹ I gave details of 102 consecutive cases of dysentery treated by a saturated solution of sulphate of magnesium, with only 1 death. I now give an account of 453 more cases of the same disease, with only 5 deaths. This makes a total of 555 cases of dysentery treated by salines, with only 6 deaths, or a percentage case-mortality of only 1.08. The 453 cases here referred to I have met with in Bhagalpur. They are of all types and forms, just as they occurred from day to day. The monthly distribution of these cases is as follows :

	Cases.		Cases.
1898, November	39	1899, June	31
„ December	18	„ July	48
1899, January	11	„ August	63
„ February	16	„ September	36
„ March	29	„ October	37
„ April	34	„ November	50
„ May	27	„ December	24
Total, 453.			

Duration of Treatment.

The number of days in hospital for the whole of these cases was 4,894, an average of 10 days for each case. The period in hospital varied from 7 to 90 days. In the vast majority of the cases of acute dysentery the period of the stay in hospital was from 8 to 12 days.

Relapses.

I made a careful nominal roll of all cases admitted to hospital during a period of fifteen months in order to determine to what extent relapse occurred. I find on checking this roll that out of 453 cases there were only 69 relapses, or 1 in every 6.5 cases. Moreover, of these 69 relapsing cases, 47 had only two attacks during the period, 15 had three attacks, and 7 had four attacks; all the rest, 384 in number, had only one attack each—a fact which of itself speaks for the efficiency of this method of treatment. I may add that the majority of these patients were long-term prisoners, and mostly under observation during the whole of this period.

As regards the interval between the relapses, I find that there were 9 relapses within two weeks of the discharge from hospital as apparently cured; 10 relapses within one month, 25 within two months, 9 within three months, 9 within four months, 4 within six months, and 3 at periods over six months. Of course it is well nigh impossible to say that the cases here called “relapses” were not sometimes reinfections, but my experience is that dysentery is essentially a relapsing disease. This is shown not only by the same patient coming back to hospital with the same complaint, but I have been able to see cases *post mortem* who died of other diseases in which partially healed-up ulceration remained, which must have dated from a former known attack some months previously.

Etiology.

In such a case it is easy to understand that any slight irritation could start another attack of dysentery. This paper does not attempt to deal with etiology, but I may mention

that, though I have very frequently found the *amœba coli*, yet there was not a single case of liver abscess among them.

Mode of Administration of Saline.

I now turn to the main purpose of this paper—the saline treatment of dysentery. The 102 cases I reported over a year ago were all treated with magnesium sulphate, which I found to act admirably, promptly, and efficiently. It happened that I ran short of that drug and took to sodium sulphate, and was so pleased with the results that I have continued its use ever since. The following mixture will be found satisfactory for general use :

R. Sodii sulphatis 5j
Aqueæ fœniculi ad 5iv

Of this mixture 3ss is given three or four times a day. Purgation should be free but gentle, and when bright yellow stools without a trace of blood or mucus are passed, then the drug should be stopped, but resumed at once if blood or mucus reappear in the stools. It is usually found that after five or six stools all blood and mucus have disappeared from the stools, but in many cases they reappear in a day or so; in such cases sodium sulphate must again be given.

This highly yellow “bilious” stool is characteristic of this drug. The only other drug I know which produces such stools is one, of unknown name, which was sent to me by Dr. Maberly, of Capetown. I used it in a few fever cases, and found that it produced copious yellow bile stools, to the great relief of the patients.

For chronic and relapsing cases I tried olive oil for some time, but gave it up as of no special value; now I treat these cases chiefly by dieting and patience. On their first coming to hospital I gave them sodium sulphate for one, or at most two, doses, and then bismuth and soda or other intestinal antiseptics. For every exacerbation—that is, for every return of blood and mucus—a dose of sodium sulphate is given, or if scybala are passed a dose of castor oil and laudanum. Intestinal worms are not infrequent in chronic cases, and when such are seen or suspected *santonin* or *male fern* should be given. I have come to consider salines (except in the limited doses mentioned above) as harmful in cases where there is ulceration of the great intestine. In ordinary cases the acute stage under this treatment is over by the third or fourth day, and if the stools remain free from dysenteric products I give a tonic of iron or *nux vomica* and *quassia*.

Diet.

Important and useful as is the saline treatment, yet dieting is equally so. For native patients (to whom alone the above figures refer) I have used the following diet during the past fifteen months, and can strongly recommend it :

For new acute cases I give what is known in India as *mar* and *dahi* 8 ounces of each two or three times a day. *Mar* is made as follows : 1 lb. of fine well-cleaned rice is thoroughly boiled with 3 pints of water, and then strained. There should then result a white starchy substance of the consistence of porridge. *Dahi* is only “tyre,” and is made daily from the milk. The two are mixed together by the patient, and eaten. This is given at 10 A.M. and 5 P.M. At 7 A.M. half the quantity is also given, except when bael fruit is in season, when bael is given instead of the *mar*. All the above patients were kept on this diet for two or three days, till the stools become semisolid, when rice milk and soup is added. Full rice diet is only given when the patient has passed solid-formed stools for one or two days.

When bael fruit is obtainable it is good to give it along with the *dahi* for the early morning meal. This is especially necessary for chronic cases, to whom also mango pickle or other antiscorbutic is also given. The bael is given in the form of a sherbet, with sugar, in the form so well known in India.

REFERENCE.

¹ *Indian Medical Gazette*, vol. xxxiii, No. 12, December, 1899.

PRESENTATION.—Mr. Lennox Browne has retired from the active staff of the Central London Throat and Ear Hospital, but will continue to be identified with the institution as Consulting Surgeon. His colleagues on the Committee and medical staff have in the past week presented him with an illuminated address recording the high appreciation of the energy, devotion, and skill which he has exercised on behalf of the hospital since its foundation in 1874. Accompanying the address was a gift of old English furniture for use in his country home.