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## MALARIA.

BY SIR JOSEPH FAYRER, K.C.S.I., M.D., F.R.S.

*Read before the Epidemiological Society*

(Read: Feb. 1st, 1882.)

THE subject of the following communication was suggested by some allusions made by Dr. Ewart in his paper last month, and by remarks offered in reference to them, in the discussion that followed.

The question raised was the old and still unanswered one, What is Malaria?

It is not with any hope or intention of supplying the information we so much desire, that I address you, but, that after referring briefly to the present state of our knowledge, I would invite such discussion as may elicit your views and gather from your experience something that may throw light on this obscure subject. It is one that has often been discussed in speech and in writing, but I doubt if ever it has been presented to an assembly better qualified than this, by experience and knowledge of every kind, to do it justice, and to put before the world such facts and explanations as may clear away the doubts that now surround it. I know I am addressing men who have had the largest opportunity of witnessing the operations of malaria, who have studied the subject practically as well as by the light of rapidly advancing knowledge of micro-pathology, and who are capable, from every point of view, in which such a subject can be studied, of investigating and revealing its nature and characters. Therefore, I venture to place it before you for discussion as one, than which there can be none more appropriate for your consideration.

What do we mean by this term, which is so familiar everywhere, and here especially? one that means so much, and yet conveys so little. The Italian word is of comparatively recent origin, and is not the one in popular use in Italy either, for there they talk of the "Cattiva-aria", though that of course means precisely the same thing, and is the popular, as distinguished from the scientific, term.

It was in Rome, about two hundred years ago, that Lancisi first pointed out the connection of agues with marshes and their emanations, and called them fevers, and the exhalations



producing them, "paludal"—as they still are called. In Rome again, a successor of Lancisi traces the connection of ague with the marshes, but this time it is not to an exhalation, but an organism, which he and his co-worker Klebs call *Bacillus malariae*. Which is nearer the truth, Lancisi or Crudelli, remains to be proved; but of this more presently. Laveran has recently discovered another micro-organism in Algeria, which he thinks is the *vera causa*.

Malaria, whatever it may be, manifests itself, and is best known by its influence on man—and animals too, as I am informed by Profs. Axe and Fleming (though this is often disputed), over a great portion of the earth's surface. It has no defined geographical limits, but practically may be said not to pass the isothermal line  $65^{\circ}$  north, and  $30^{\circ}$  south latitude; and not to appear when the diurnal range of temperature is below  $60^{\circ}$  Fahr. It becomes more intense and active, generally, approaching and within the tropics.

It is very much regarded as a tropical evil, and so indeed it is, but not by any means exclusively so, for it is found all over Europe, in the south especially; and the Campagna of Rome, the Pontine marshes, the banks of the Danube, the fens of Holland, the rocks of Greece and Gibraltar, all maintain an evil celebrity.

In nearly all continental Europe there are malarious regions; Spain, Italy, France, Germany, Greece—even our own country is not exempt. Once we were a very suffering people, and lost two kings, a queen, cardinal, a lord protector, and many other great people, from a disease that is now almost unknown, at all events in its severe forms, though it still lingers in some districts of the south and east of England. Why this change? It comes of better drainage, better houses, better food, better personal and general hygiene, and therefore it is full of encouragement for other countries; and are we not now profiting by this experience, and thus gradually diminishing disease everywhere? Dr. Chevers, who for years has taught the Government and people of India how they might preserve their lives and health, will tell you that, by degrees, it is being recognised and shown that people need not die as fast as they did, even in India, and as we have reduced the mortality of soldiers, who are under control, from 60 to 16 per 1,000, from 13 to 3 of fever alone, so we may do, and indeed are doing, much more still; but how much remains to be done! About 3,500,000 natives die yearly in India of fevers. No doubt registration is still imperfect, though they are doing all that is possible to improve it, and deserve immense credit for what they have done,



and very probably 50 per cent. of these who die do not die of malarial fevers but of thoracic complaints, and others with a hot skin. Still, if one and a half million of people die of undoubted malarial fever, to say nothing of the other one and a half million, and of thousands who perish from dysentery, diarrhœa and other complaints, such as cholera according to some, etiologically linked with this class of malarial fevers, is it not prodigious? The great cause of this mortality is the unknown thing or condition or group of conditions, called malaria. Some call it climatic influences, sudden alternations of temperature, chill only. But is this the case? Can a chill, or can any agency irrespective of something ingested or inhaled produce such effects? Hippocrates and his predecessors probably knew that people who lived near marshes got intermittent fevers, but they did not know of malaria, or think of fevers and paludal exhalations, in connection with each other, as cause and effect. It was Lancisi who first attributed fevers to marsh exhalations. Agues, remittents, pernicious, masked fever, and other paludal cachexiæ have long been known, but they are not worse in the Tropics than they are now, or have been in Europe in past times. Read Pringle's valuable work, Lind, Ferguson, MacCulloch, and others of that time and at a subsequent date; or go back further, and read Lancisi and Sydenham, and you will see that not the coast of Guinea or the Nepaul Terai can give you anything much worse than Europe did in those times, and could do now under certain conditions we hope never to be revived. Read Pringle's account of the state of the army in Flanders, or even in Scotland before and after Culloden, and you will understand that tropical fevers differ more in intensity than in kind from fevers in temperate climates. Clarke says, that in Calcutta in 1780, about 80,000 natives and 1,500 Europeans died of fever annually. In 1880, 3,797 died, all told, of fevers, chiefly malarial.\*

\* *Prevalence of Fever and Causes.*—The registered deaths from all causes in India in the year 1879 were 4,975,042.

Cholera accounting for	...	...	270,552
Small-pox accounting for	...	...	194,708
Bowel complaints accounting for	...	...	250,173
Fevers accounting for (out of a population of 187,105,833)	...	...	3,564,035

*Civil Population, Fever Deaths.*

1877	...	...	2,504,493
1878	...	...	3,247,371
1879	...	...	3,564,035

or thirteen times as much as cholera; though it may probably fairly be



What then is the nature and *raison d'être* of this mysterious agent, so destructive to our race and yet so amenable to sanitary interference, and which all over the world, under certain atmospheric and telluric conditions, produces so much

estimated that not more than 50 per cent. of these deaths are due to endemic fevers.<sup>1</sup> In the case of certain classes subject to registration, the figures are reliable; those relating to the general population are probably less trustworthy, but still sufficiently accurate to give a tolerably correct idea of the prevalence of disease and extent of mortality.

Let us look at the statistics of fever-prevalence as illustrated by the sanitary reports and returns of hospitals in Calcutta.

The mortality from "fevers" in Calcutta has been, during six years :

1875	...	...	5,328		1878	...	...	6,186
1876	...	...	4,361		1879	...	...	4,796
1877	...	...	5,151		1880	...	...	3,797

Clarke says that in 1770, 80,000 natives and 1,500 Europeans died from fever in the city of Calcutta.

The British army in India in 1879 numbered 57,810 men; of these 51,959 suffered from fever, with a mortality of 387.<sup>2</sup> The Native army,

<sup>1</sup> In the present state of registration it is not possible to define the special character and type of these fevers. They are certainly, for the most part, malarial in character. Attempts have often been made to arrive at the actual number of true fever-deaths, and they all agree in showing that fatal diseases attended by heat of skin and other febrile characters are returned as fevers. In the Chanda district, out of 1,008 deaths, the Civil Surgeon found that 672, or 66.6 per 100, were due to fevers properly so called. The Civil Surgeon of Betul reports that out of 208 deaths 66, or 31 per cent., were fever deaths, and so on. The Civil Surgeon of Mandla states that from personal inspection he has ascertained that fever forms 7.5 per cent. of the mortality. The Civil Surgeon of Wardah gave the following result of personal inquiry into the cause of 69 reported fever-deaths.

18 died of remittent fever.		2 died of pleurisy.
9 died of bronchitis.		2 died of peritonitis.
8 died of ague.		3 died of vermes.
3 died of continued fever.		

Suppose 50 per cent. die of fever, the loss of life is great.

<sup>2</sup> The mortality of the British troops in the Bengal Army during sixteen years, 1830 to 1845, gave a ratio of 13.25 per 1,000 from all fevers.

The same for 1875 was only 2.77 per 1,000.

"	1876	"	2.46	"
"	1877	"	2.21	"

In 1878-79 there was more fever from the famine and Afghan War. These three years appear to be normal.

Army of all India for five years, 1871-75:—

Deaths from all fevers, 1875=2.81 per 1,000.

"	"	1876=2.41	"
"	"	1877=2.16	"
"	"	1878=5.07	"
"	"	1879=6.55	"

The rates for 1878-79 were part of the great fever epidemic which swept over India and occasioned enormous losses to the civil population. The rates include the Afghan fever and those on the march of troops.



disease and mortality that it has been called the destroying angel, whose mission it is to keep the population of the world in check; producing disease too of a peculiar type, and having the power of establishing a diathetic condition in

of 130,011 men, had 122,375 cases of fever with 756 deaths. The jail population, of 117,680 persons, had 73,484 cases of fever with 1,306 deaths. 1879 was an unusually unhealthy year, epidemic fevers of a malarial type were prevalent and fatal. In some districts, during and after the close of the rains and beginning of the cold season, the mortality was very high. In Bolundshur and Allyghur the deaths rose to about 113 per 1,000 of population, the mortality from all causes being but little in excess of that of fever alone<sup>1</sup>

The population of Bengal, under registration, in 1880 was 59,890,237; about 4 per cent. located in towns, 96 per cent. in country and villages. The deaths registered in the whole province were:—

Cholera	...	...	...	...	39,643
Small-pox	...	...	...	...	22,953
Fevers	...	...	...	...	689,605
Bowel complaints	...	...	...	...	44,969
Injuries	...	...	...	...	22,339
All other causes	...	...	...	...	103,124
Total registered deaths					922,633

Fevers destroyed nearly three times as many as all other death-causes put together.

#### BOMBAY.

Seasons.				Registered Fever Deaths.	
				1880.	Mean of 14 years.
Cold	...	...	...	93,800	63,446
Hot and dry	...	...	...	38,488	28,304
Rainy	...	...	...	73,746	62,992
Hot and damp	...	...	...	40,745	38,773
Total	...	...	...	246,779	193,515

#### The Deaths for each month being

January	...	...	24,689	July	...	...	18,922
February	...	...	22,625	August	...	...	19,856
March	...	...	23,921	September	...	...	18,396
April	...	...	19,901	October	...	...	18,406
May	...	...	18,579	November	...	...	22,339
June	...	...	16,572	December	...	...	22,565

The seasonal prevalence (*vide* Table) shows how cold and variable

<sup>1</sup> "The unusual rise in the fever mortality was marked in August and September, was at its height in October and November, and then gradually declined" (*Sanitary Commissioners' Report* for 1879, page 78). The Sanitary Commissioner of the North-West Provinces remarks:—"Everywhere the rise, culmination, and decline happen at the same time, and as from a cause co-existent everywhere in the Province. This cause was malaria, and it is attributed to excessive rainfall following two years of comparative drought" (*Sanitary Commissioners' Report* in 1879, page 78).



those who have been exposed to its influences that shall affect them for the rest of life, and reproduce on the banks of the Thames that which was inaugurated half a century before on the shores of the Hoogly, the Indus, or the Congo?

Marsh miasm and marsh malaria are inappropriate names, however, for a disease-cause that is often generated where there are no marshes, and which is often as active in its manifestations on sandy, rocky, arid ground as in swamps. It has been shown over and over again, that the desert plains of north-west India, as well as arid regions in other countries, where there is no apparent surface water, and little or no vegetation—such as on the granite rock of Mount Aboo, on the magnesian lime-stone of Kurachee, the Island of Ascension, Rock of Gibraltar, and other similar localities—these fevers of a periodic type abound, and that a soldier may come away as fever-stricken from Peshawar as from the Soonderbunds. No part of the 1,600,000 square miles of India seems to be quite exempt, except perhaps the higher hill stations, and even they are doubtful; it is thought by some that above 3,000 to 5,000 feet it is absent, but this is a mere approximation. It is the fashion to speak of malarial and non-malarial localities, but in India, in the sense of producing fever, all are malarial. If there be one thing of which, by evidence, we are more convinced than another, it is that somehow water-logged land, *i.e.* land where the subsoil water is near the surface and stagnant, is the chief determining cause. The surface may be dry as it was at Walcheren, but if it be porous, and the air can get at the stagnant water, with perhaps ever so little organic matter below, and if there be a temperature above 60° Fahrenheit, then the state of things, or the thing itself we call malaria, may occur. This seems to be proved by what occurs in the Doab, between the Ganges and Jumna, and in other districts where irrigation canals bring in more water than is needed for the wants of agriculture; the land becomes water-logged, and in the absence of drainage, the fevers pre-

temperatures affect the etiology of these fevers. The contrasted mortality between that of the hot and dry, and the rainy and damp seasons shows the effects of added moisture on the amount of fatality. The fevers in these returns are all placed under one general heading—the types comprehended being the malarial and continued. Among them, no doubt, are included deaths due to other inflammatory disorders, such as pneumonia; whilst, on the other hand, not a few of the deaths from dysentery and diarrhœa belong more properly to malarial fevers. Registration is rapidly improving, but is not yet perfect.



vail in a degree unsurpassed by any part of the country, except perhaps in the Terai.\*

For example : The population of the North-west Provinces and Oude in 1881 was 44,107,061; the deaths from fever amounted to 987,220, nearly a million. The death-rate in the Terai was nearly 53.41; in Roy Bareilly 21.72. The irrigated districts of the Doab, which come next, are nearly as bad as the Terai, and we have had, for some years, opportunity of watching the effects of subsoil water in excess in producing fever in the province of Burdwan, in Bengal, which became simply water-logged by arresting

\* *The Sanitary Commissioners' Report of December 31, 1880*, contains much information in respect of the prevalence of fever, the causes of malaria, and the influence of irrigation on fevers. This province includes the pestilential Terai and the Doab, an irrigated area which was scarcely less unhealthy.

Population of Oude and North-West Provinces, 44,107,061 in census of 1881. The registered deaths for five years, including the period of scarcity, was :—

Years.	Total Deaths.	Deaths per 1,000 population.
1876	937,490	21.94
1877	840,538	19.67
1878	1,521,724	35.65
1879	1,914,499	44.81
1880	1,281,155	29.99

The improvement in 1880 follows relief from scarcity. The lowest death-rate in 1880 was 21.72 in Rai Bareilly. The highest in the Terai 53.41. The chief death-causes in 1880 :—

Diseases.	Total Deaths.	Deaths per 1,000.
Cholera ... ..	71,546	1.67
Small-pox ... ..	8,240	0.19
Fevers ... ..	987,220	23.11
Bowel complaints ... ..	80,312	1.88
Injuries ... ..	20,553	0.48
All other causes ... ..	113,284	2.65

About twenty-three out of every twenty-nine deaths were due to fever. The mortality caused by small-pox, cholera, and dysentery, is nothing in comparison with that from fever. Nearly a million of people (987,220) died in 1880 of malarial diseases. The liability to fever here seems to have been increased by other predisposing causes, the most important being under-feeding; but as this was not the case with the entire population, and as they were not all badly clothed and housed, though all suffered, it is evident that there were other causes in operation.

*The Sanitary Commissioners' Report for 1879* shows that the general causes which influenced the public health in fever localities, were undrained ground into which canal-water had been led, and rainfall added to the already water-logged subsoil. In 1880, food became cheaper, and except in certain districts there was less rain. In 1879, during the great scarcity of food, the fever death-rate was 37.82 per 1,000; in 1880, it fell



or altering the natural course of streams and interfering with subsoil drainage. It was nearly depopulated by a low form of fever, call it malarial, typho-malarial, or what you will. Certainly the greatest weight of evidence seems to support the theory of stagnant subsoil water, and organic matter at a certain temperature, as the cause. But the subsoil water must be STAGNANT to make it dangerous. When it moves, as it often does, ever so little, it is no longer so detrimental. Some would exclude the necessity for organic matter at all, considering moisture and earth to be sufficient without it; this may be so. Others think, or suggest, that animal, combined with vegetable organic matter, may have peculiar effects, according to the relative quantity of each. What tropical marsh exhales vegetable decomposition alone? It

with increase of food to 23.11 per 1,000, which was still above the five years' average of 20.91 per 1,000.

The monthly fever mortality for the whole registration area was:—

*North-West Provinces, 1880.*

Months.	Fever Deaths.	Months.	Fever Deaths.
January ... ..	116,366	July ... ..	56,502
February ... ..	72,030	August ... ..	74,127
March ... ..	69,250	September ... ..	87,618
April ... ..	72,534	October ... ..	91,248
May ... ..	76,622	November ... ..	99,459
June ... ..	78,200	December ... ..	93,264
Total ... ..	485,002	Total ... ..	502,218

The total annual deaths from fever, taken through the scarcity period were:—

1877 ... ..	574,722	1879 ... ..	1,616,108
1878 ... ..	982,117	1880 ... ..	987,220

The fundamental cause of the great loss of life from fever, was increased predisposition from scarcity of food. Cold, damp, and alterations of temperature in the latter half of the year, and dampness of soil, the result of irrigation throwing more water into the subsoil than was needed by growing crops. This must have acted as a serious predisposing cause.

The chief engineer was of opinion that the fever is *not* due to irrigation, but to great diurnal range of temperature, chills, and imperfect feeding. He says:—"Without the great diurnal range, canal irrigation will not produce malarial fever;" but, he admits, that under these climatic influences it may do so, especially in the winter months, and thinks that better clothing and food would protect the people. But we know that these fevers occur irrespective of changes of temperature, though, no doubt, they have much influence in re-exciting it in those who have previously suffered, but not *de novo*. Fever occurs in every month of the year, though more in some seasons than others. With the excessive mortality in irrigation districts, the conclusion is inevitable that the true cause is stagnant subsoil water. The remedy for all this is better drainage, whilst no more water should be used than is required for the crops.



must be mingled with the miasmata of decaying animal life of low forms.

If malaria be a miasm, an exhalation, is it one, or are there many? Does the same thing produce fatal remittent fever and slight malaise? Is one, only the result of concentration, the other of dilution, of the poison? Is the malaria of a granite rock, or of a sandy arid plain like Sinde, or parts of Spain, the same as that of a marsh, or a mangrove swamp? How does it differ from that of a rubbish-filled tank, dry ditch, moat, drain, cesspool, pond, tank, some upturned earth, mud, or soil, exposed to the light and air after a jungle has been cut down, the bilge of a ship, etc., etc.? MacCulloch says malaria comes from every pond, ditch, hole, coppice, wet grass, or ground in England, and that the malaise is experienced by those who live in damp houses in the neighbourhood of ponds, or which are surrounded by moats, and so on; or even a flower-pot, a watered flower-bed, is only different in degree from that which strikes a man down in an algid pernicious fever, or coats his tongue and teeth with sordes like that of typhus.

All these are questions unanswered, but such as must suggest themselves to those who have had to deal with the matter practically, as well as to those who only deal with it statistically. No one has seen or found any tangible or particulate thing as yet that can be relied on. I come to Klebs, Crudelli, and Laveran presently, "*La terre est riente et fertile, une fraîcheur délicieuse vous repose le soir des chaleurs brûlantes du jour—et tout cela c'est la mort.*" You remember the description of the "*cattiva aria*", in the Villa Borghese, by Madame de Stael. Chemists have done their best; many foreign matters have been detected, gases, organic matter, and so on, but none of these is the malaria. The Italians have lent us two words—malaria and influenza—both expressive of much, yet descriptive of nothing. Influenza is more vague even than malaria, for it deals with a more complete abstraction. If an impression made through the cerebro-spinal and vaso-motor system from without by heat, cold, electricity, or from within by an emotion, or in any other way by which the body may be affected, can produce acute catarrhal, bronchial, intestinal, febrile, or nervous symptoms, why may not such a cause explain the phenomena ascribed now to malaria, as an entity, *i.e.*, a gas or a germ?

Some such view is held by highly experienced men at present, and was in past times by others. Read what Ferguson said last century; what Drs. Gordon, A. Smith, Moore, Oldham, and



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others say now. There certainly is much in the character of Indian fevers to support these views, which are eminently deserving of consideration. For my own part, I must say that I cannot feel convinced that merely climatic influences, alternations of temperature, abstraction of heat, can account for a tertian or remittent fever. There must be, I think, a "tertium quid", but I do not know what it is. Chills, cold, and damp will reproduce ague in one who has suffered before, or will develop it in those who have lived in a so-called malarious country, though they never had fever when there; but it will neither cause fever *de novo*, nor that peculiar cachexia with which many of us are so familiar.\* Now, whether this subtle addition is a chemical molecule, or an organic germ; an emanation, or a bacillus; or whether it is only the outcome of the forces which surround us, and of certain external influences acting on the cerebro-spinal centres, and producing certain nutritive changes, and perhaps developing an autogenetic poison, is the question which needs solution.

The interesting researches of Klebs, Crudelli, Laveran, and their Italian and French followers, as Dr. Henderson told us not long ago, in a very able summary of the most recent researches into this branch of science, are the latest attempts to define malaria. According to Klebs and Crudelli, bacillus† seems to be at the root of this as of so many other evils; if so, what a monster he is despite his littleness! Think of a microscopic rod causing half the mortality in the world! People thought badly enough of the cobra for slaying 20,000; the bacillus slays his millions yearly. But does it really do all this? Is it really the *teterrima causa*? Is all the periodic fever, dysentery, some would say cholera, diarrhœa, cachexia, spleen, beri-beri, etc., due to this microphite? Dr. Sternberg, who has repeated Klebs and Crudelli's experiments with great care, says that he does not deny the possible connection of fever with bacillus, but the causal relation is not yet proved. Still the weight of evidence at present seems to be in favour of the bacillus; but think of all it will have to explain.

Those who have lived in India or other malarial countries and dealt with malarial diseases, and have seen the extraordinary caprices and results ascribed to malaria, will find it hard to explain on this basis. For my own part, I am not

\* The great tendency now-a-days is to trace all disease to a specific cause, but we must not lose sight of the possibility of causes developed in the body, and altered conditions of the nerve-centres and vaso-motor action, and so on, by forces influencing from without.

† According to Laveran, a ciliated corpuscle.



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convinced. But I am convinced that we are infinitely indebted to those who are working out these difficult and interesting problems in such a truly scientific spirit, and that it would be most presumptuous to assert that their researches will not be successful in solving this venerable puzzle. What, then, best meets the case? What will best explain all the seeming contradictions? Will a gas, an aeriform imponderable thing, or a germ imperceptible to our microscopes or in our test-tubes, or will the result of a variety, or combination of abnormal conditions which are capable of acting on the centres and vaso-motor mechanism, so as to induce internal congestion, structural visceral change, or those nervous phenomena, alterations of temperature and nutrition, that are comprehended in an attack of fever, do so? This is the question that we want to solve.

Meanwhile, I content myself, provisionally, with the working hypothesis of an entity "malaria", and speak of *it*, and its influences, as though it really were a particulate thing. Klebs and Crudelli's bacillus theory is beautiful, and explains as much, if not more than, any theory that has preceded it; still it wants confirmation. Theories of an organic cause are not new; from Vario and Lucretius down to Linnæus, thence to Salusbury and others, such views have been put forward and again been laid aside, but never stated with such force or probability as by Klebs and Crudelli; and these are already disputed. I do not know yet what Indian research has done in this matter, but it is in competent hands. As it stands, we must accept the bacillus theory with caution; for however much we may be inclined to do so, it would be as rash to accept it as established, as it would be presumptuous to assert that it will not be so.

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