"THE PREVENTION AND CURE OF MALARIA, WITH SPECIAL REFERENCE TO GREEK MACEDONIA."

A THESIS

for the Degree of

M. D.

By

JOHN STEEDMAN,

M.B., Ch.B., B.Hy., D.P.H..

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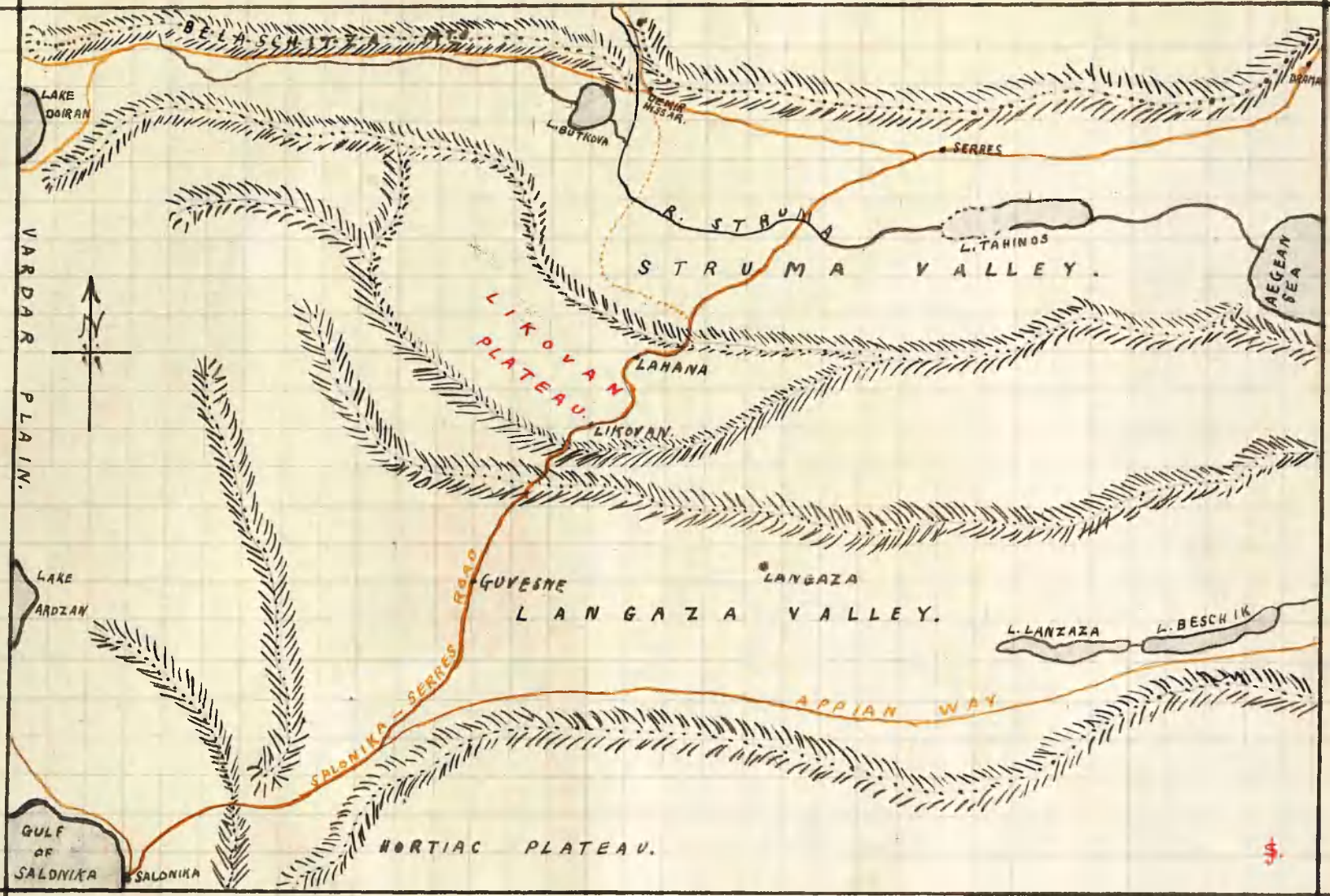
"THE PREVENTION AND CURE OF MALARIA, WITH SPECIAL REFERENCE TO GREEK MACEDONIA."

As Malaria is responsible for incapacitating such a large number of western Europeans, who are exposed to infection, it is felt that every investigation that can throw any light upon the prevention or cure of this scourge, ought to be encouraged, and every information derived therefrom, be made known. It is with this end in view, and the hope that my experiences of the prevention and cure of this disease may help to attain this object, that I present this thesis.

During the war, now happily ended, I was stationed with our own, and also Greek, troops, in Greek Macedonia, from the autumn of 1916 till February 1919. During the larger part of that time I was actively engaged in what was officially known as "Anti-Malarial" work. During the summer of 1917, I was in the Struma Valley, a region notoriously well known as a hot-bed of Malarial infection. The following summer I was Anti-Malarial Officer for the Army Corps to which I belonged, and had the supervision of all the Anti-Malarial work within that area. I had thus ample opportunity to investigate the contributory causes of Malaria, and also of experimenting as to the various means of preventing these.

That part of the Balkans with which I was most actively interested, was the area between Salonika and the front line, stretching across the country from Lake Doiran on the west,


BELASCHITZA MTS.
LAKE DOIRAN
L. BUTKOVA
DEMIR HISSAR
SERRES
R. STRUMA
L. TAHINOS
AEGEAN SEA
STRUMA VALLEY.
VARDAR PLAIN.
LIKOVAN PLATEAU.
LAHANA
LIKOVAN
LAKE ARDZAN
GUVESNE
LANGAZA
LANGAZA VALLEY.
L. LANZAZA
L. BESCHIK
SALONIKA — SERRES ROAD
APPIAN WAY
GULF OF SALONIKA
SALONIKA
HORTIAC PLATEAU.

to the Aegean Sea on the east. This front area was situated about ninety Kilometres north of the Gulf of Salonika,and constitutes the area known as Greek Macedonia.

FEATURES OF THE DISTRICT. The area mentioned above is a country consisting of ridges of mountains,cut into by deep ravines,and gorges,with wide flat plains between,varying from five to twenty kilos across. Proceeding from the sea-board at Salonika,the road rises to the first ridge fourteen kilos from the town,and dips down again to the broad flat Langaza Valley. It crosses this valley at a point where it is eighteen kilos wide,and rises again to a height of over four hundred and fifty metres. This ridge is sharply cut off from another and a higher by a narrow valley - almost a ravine - and from this point onwards to the sixty-fourth kilo is a plateau about five hundred and fifty metres in elevation. The next two and a half kilos show a sudden drop into the Struma valley. This,in turn is bounded on the north side by a range of mountains - The Belaschitzas - reaching to a height of Twelve hundred metres,at this part. This range sharply defines the limit of the intense mosquito breeding area,though mosquitoes are found on the other side,but to a much less extent.

Both the Langaza and Struma Plains are very flat, and lie only a few feet above sea level,with the result that the ground water level is high.Thus,even in the height of the "dry" season,one has only to dig a few feet to come upon an

ample water supply. As might be expected,vegetation is profuse here,and in this area is grown a large part of the so-called "Turkish" tobacco that is imported to Britain as the " Abdulla " brand. Water melons and gourds are very prolific here,both instancing the water held by the soil. Wells are dug with very little manual labour,and when they become silted up,the native finds it easier to dig fresh ones than to clear out the old. This practice gives rise to many water holes,which form one of the commonest types of mosquito breeding places one finds. In the deep ravines on the hill sides,many rock pools are found,even for months after the water has ceased to flow,and here also one finds a fruitful source of mosquitoes, As the streams reach the plains, they become sluggish ditches with densely overgrown banks,full of sedges and weeds,and ultimately lose themselves in broad marshes,which eventually merge into lakes. In the Struma Valley two such lakes exist,known as Butkova and Tahinos, situated about eighteen kilos apart,while in the Langaza Valley are other two,Beschik and Langaza,running the one almost into the other,the easternmost emptying almost directly into the sea, through a narrow gorge. These last two lakes are situated alongside the "Appian" way. As the temperature of this area in the summer is high,reaching in the months of August and September to over a hundred degrees Fahr. in the shade,it will be seen that all the conditions favourable for mosquito life are present, and as a result we find that throughout the whole of the area I have mentioned,Malaria is rife.

The prevailing winds here are East or West,both of which are warm,and the cold north wind,owing to the topographical features of the country,are excluded,thus further favouring insect life.

The prevailing type of the disease in this area is of the Benign Tertian variety,though cases of the Quartan are also found. During the later part of the Malarial season in particular,which extends from May till November,a certain number of cases of malignant Tertian were found. Amongst the native population,the same rule holds,but they exhibit less acute symptoms,and many of them indeed show marked insusceptibility,suggesting an acquired immunity to the infection. As a raee they show effects of the ravages of the disease,having sallow parchment like skin,with more or less marked anaemia,in other words,a distinct Malarial Cahexia.

HISTORICAL OUTLINE. Researches into the history of Malaria take us back a very long way. It is said that the "plague" that attacked the Greek Army before Troy was really Malaria. This may,or may not,be the case,as it all depends upon the interpretation put upon the word as used by Homer in the Iliad,XXI,31.

In Europe,particularly in Greece and Italy, Malaria has been known to exist for about two thousand years. It has made its greatest ravages when attacking virgin soil, and it is scarcely to be believed that it was very prevalent

in Greece while that country was at the height of its fame. It is more probable that,with the introduction of the scourge came the commencement of its decadence,for it is a fully recognised fact that a race which may be virile and warlike,will soon lose those attributes when it is exposed to the ravages of this disease. It saps all the vitality of the community,and to each member of it,it adds to the size of his spleen what it deducts from his stature,and leaves only a shrivelled husk of what existed as the national characteristics before its advent.

In that part of Greece within which I had the privilege to work,one saw very little of the type of individual that one pictures as taking part in the Olympic Games,or any of the manly games of ancient Greece.

Jones,in his work on "Malaria and Greek History" draws attention to the fact that,according to Hippocrates, Paludism was known to the medical schools of Greece before his day (400 B.C.),and that,from the "Wasps" of Aristophanes (425 B.C.) it was attracting notice at Athens at that time.

Ross points out that he is not of opinion that Malaria was rife in the Greece that we read of in history, as the athletes could not have indulged in the necessary sports with the enlarged spleens that must have accompanied their condition. Certainly this idea,when applied to our own troops stationed in the Malarial areas during the war,is pregnant with suggestion. Men who had suffered from the disease were totally

unable to participate in the usual outdoor sports,and were even in large measure incapacitated from duty. Speaking of the native,under like conditions,Jones,in his work,remarks "Malaria made the Greek weak and inefficient;it turned the sturdy Roman into a bloodthirsty beast". Monfalçon attributes abortion drunken-ness,and various classes of crimes either directly,or indirectly,to Malaria.

In addition to the loss to a State by the enervation of its people,the loss through untilled acreage,loss of time through sickness,and death,is untold. It is estimated that the loss to the Southern States of America is at least fifty million dollars per annum.

The importance to the world at large of the subject of Malaria,is evidenced by the fact that two of the Nobel Prizes in medicine have been awarded for work done in connection with this disease - to Ross in 1902,and to Laveran in 1907.

The fable of Hercules overcoming the Hydra,is supposed to typify the reclamation of the marshy land.It is possible,however,that this reclamation was purely for agricultural purposes,but nevertheless it is possible also that the attempts at abolition of "Miasmatic Fever" had some part in it.

Hippocrates divided Malaria into 'Fevers,continuous and intermittent,' and also a further subdivision into Quotidian, Tertian,and Quartan.He even at that time recognised the effects of rainfall,seasons,and stagnant water as etiological factors,

and points out the dangers of malignancy,dropsy,and splenic complications.

Roman writers do not make much reference to this disease.The earliest is Plautus,who died in 184 B.C.;Cato makes mention of "black bile and swollen spleen",and Cicero,Celsus, and Livy show a knowledge of the disease.

Passing through the middle ages,the names of Morton,Sydenham,and Torti,stand out. Morton,in 1697 describes accurately the pernicious and simple intermittent fevers,and attributes them to miasmatic effluvia. He strongly advocated the use of cinchona,the value of which was at that time being strongly contested. Sydenham,in 1723 also accurately described Malaria Fever,and divided intermittent fever into 'Spring' and 'Autumn' fevers. He also strongly advocated cinchona,used it himself,and formulated rules for its administration. Torti,in 1753,wrote an exhaustive treatise on Malaria,and his detail of the pernicious form has become classical. It is worth recording that Mitchel,in 1849, claimed to have discovered in the sputa of cases of Malaria,a spore-like body which is common in marshes,and suggested this as the cause: Salisbury in 1866 found in the urine and sweat of such cases a species of alga called PANELLA,which he alleged was the causative factor. In 1847, Mitchel described pigmented bodies which correspond to the Malarial parasite. Virchow in 1849 and Frerichs in 1866 depicted cells now known to be parasites. None of these invest-

igators however recognised the full significance of these, and their parasitic nature was not suspected till in 1880, Laveran described them, and to him the honour is due. His theory was not accepted by the medical world till several years later, but the work of later investigators confirmed this, and it is now accepted the whole world over.

The work of Golgi in particular, was of importance in the next step of investigation, that of following out the life history of the parasite. Next followed the theory of mosquito origin of the parasite, and after various attempts, particularly of Dr Josiah Nott, in 1848, to probe this, Ross, working at the suggestion of Manson, proved conclusively that certain species of mosquito acted as hosts for the parasites. This completed the chain of evidence by which the Anopheline mosquito stood convicted of being the harbourer and disseminator of this plague. In 1898, a further important discovery was made by MacCallum, who found that the flagella previously described by other writers, were really the male sexual elements of the parasite.

Malaria is supposed to have been introduced into America from Europe, just as, vice versa, Syphilis is supposed to have come from America to Europe. In the continent of America, it has assumed very wide distribution. In North America, the South Eastern portion of the United States is chiefly affected. Along the Atlantic coast, south of New York, and in The Carolinas, Georgia, and Florida, the disease occurs frequently. Along the

Gulf coast,and up the Mississippi River,and its tributaries, Malaria is very prevalent. In the New England States,Malaria is still found,and in the southern portion,is even on the increase. Along the Pacific coast it is much less prevalent.

Canada is free from Paludism except along the northern shore of Lake Ontario. In Mexico,severe forms of Malaria occur,particularly along the coast region.

In Central America,Malaria abounds along the Atlantic coast,and to a less degree on the Pacific side. In South America,as in North,the eastern coast is much more affected than the western.

It is in the Panama region that we have the most outstanding features as to what can be done in the way of preventing Malaria. Here the work of Col. Gorgas,of the United States Army is world famous. He was appointed chief Sanitary Officer of the Isthmian Canal Commission,and contributed another and most important chapter to the growing volume of Sanitary Science. He demomstrated beyond question the efficiency of an organised system of sanitation,in a field presenting all the difficulties and all the destructive influences which characterised territorial areas in the tropics. He has shown that, in spite of the normal conditions of perverted states of health, the offspring of soil and climatic conditions,these lands of our globe may be so purged of disease and purified by systems of sanitation,that they will assume in all respects the states of

health belonging to a temperate clime. His work marks an epoch in the progress of the world,and teaches a lesson that he who runs may read. For four hundred years before his time, the tract now known as the Isthmus of Panama was notorious as one of the most unhealthy parts of our globe.

Many people attempted to cross the tract in 1849, during one of the Californian gold rushes,in preference to the long and tedious voyage round Cape Horn. On foot,on mules, and in vehicles of all sorts,they trailed away from the coast into the swamps,in torrid heat,under blistering sun,and in torrential rains. Many of these fell by the wayside,victims to the fierce onslaughts of the native Anophelis,who welcomed the invasion of new and fresh blood. In 1855,a railway was opened across the Isthmus,which engineering project took heavy toll of the lives of the workers.

In 1887,a French company attempted to cut a canal through here,and worked on for eleven years,when the effort was abandoned,defeated by the mosquito. In 1904,Col.Gorgas, fresh from the victories won by him in Cuba, was made Chief Sanitary Officer of the zone, and began the colossal work of making a territorial area of three hundred and twenty-two square miles,surcharged with disease-producing causes,into a region so free from disease that the mortality among the officials and work-people is not now greater than that of towns and cities of our own country.Not only was he charged with converting the

recesses of the jungle into healthy homes for employees, but also had the difficult task of renovating two cities,aggregating a population of fifty thousand people,one of which had been for two and a half centuries a hot-bed of pestilence and disease. He adopted as his standard two maxims,and carried these out religiously,and attained by them the above mentioned results. These were:-

(a). The prevention of disease,by removal of the cause,and,

(b). The care of the sick,both for the sake of themselves, and for the safety of those around.

In carrying out his scheme,he ruled the inhabitants with a veritable rod of iron. He had a perfect system of house to house inspection,including the most intimate parts of the homestead. All water pails and water barrels, and utensils which contained water,or could conceiveably do so, were dealt with,by covering with netting,if of use,or by destruction or burial,if useless.Rain gutters and spoutings were inspected weekly,and if defective,were ordered to be repaired,and if not done at once,were pulled up,or pushed down,whichever would prevent them holding water. He had,on several occasions, close upon a riot over his stern measures,but gradually the people he had to deal with,became educated up to the standard at which they appreciated the reason why these measures were necessary, and the results proved his justification. No greater achievement is to the credit of medical science than that attained here.

Jungle areas that were impenetrable to anyone,save only the few disease-ridden natives who had their homes there,were made habitable for skilled white work-men,whose work necessitated their residence there. Harbours that had been recognised as plague spots,where ships had been known to lie at their moorings,while their cargoes rotted in their holds,for want of crews,through death from disease,are now harbours,where maritime life is carried on in all its bustle,and along the shores where none but Anophelis and Stegomyia held sway,are now summer villas and holiday residences,secure in the protection that medical science has assured them. These instances show what prophylactic measures can achieve,and what has been done here, can also be done elsewhere.

The area in which most of my own work was carried out,is one of the most fertile to be found in Europe,but development is retarded on account of this scourge,and only by adopting similiar methods here to those used in Panama,can the full resources of the country be developed. Greek Macedonia has suffered so seriously from neglect whilst under the rule of the Turk,and from the recent Balkan wars,that no check whatever has been put upon the development of the Malarial mosquito, and the result is now,that while the country is under the Crown of Greece,it is actually under the control of the Mosquito. The villages in which the natives reside are very scattered,and the number of medical men is small,even in peace time,though

the population have almost forgotten what peace means. They regard Malaria as an integral part of their existence,this apathy being in itself one of the evidences of the disease in this area. Quinine is a government monoply,this having been done under the "Greek Malaria League",with,doubtless,the intention that the control of the drug should be for the benefit of the people,but the result is that it is scarcely to be obtained,and then only at a much enhanced price,far beyond the means of the average native. Even the most ignorant of the inhabitants realises the value of the drug, placing it on a par with his bread,which is very high in his scale,but,while he seldom has to go without the latter, he seldom sees,let alone obtains,a supply of the former.

During one part of my sojourn there,I had a daily parade,among the inhabitants of one of the villages - Likovan - and I was informed by the Mayor,a man of more than the average intelligence,that the health of this village was better maintained than it had been for years. I mention this,simply to show at this point that,given the means of dealing with this area, the people themselves are already cognisant of at least the value of quinine as a therapeutic agent,though they know practically little or nothing of what prophylaxis means.

ETIOLOGICAL CONSIDERATIONS. When one considers that the disease Malaria depends upon the life histories of three animals - Man, Mosquito, and the Parasite - one can appreciate the fact that etiologically it is rather complex.

While within the blood of man, the parasite is not subjected to much variation of environment, irrespective of all changes of temperature, season, or latitude, but at the same time exposure of the infected person to cold, wet, or heat, or dietary or other excess, may have the effect of awakening latent Malaria.

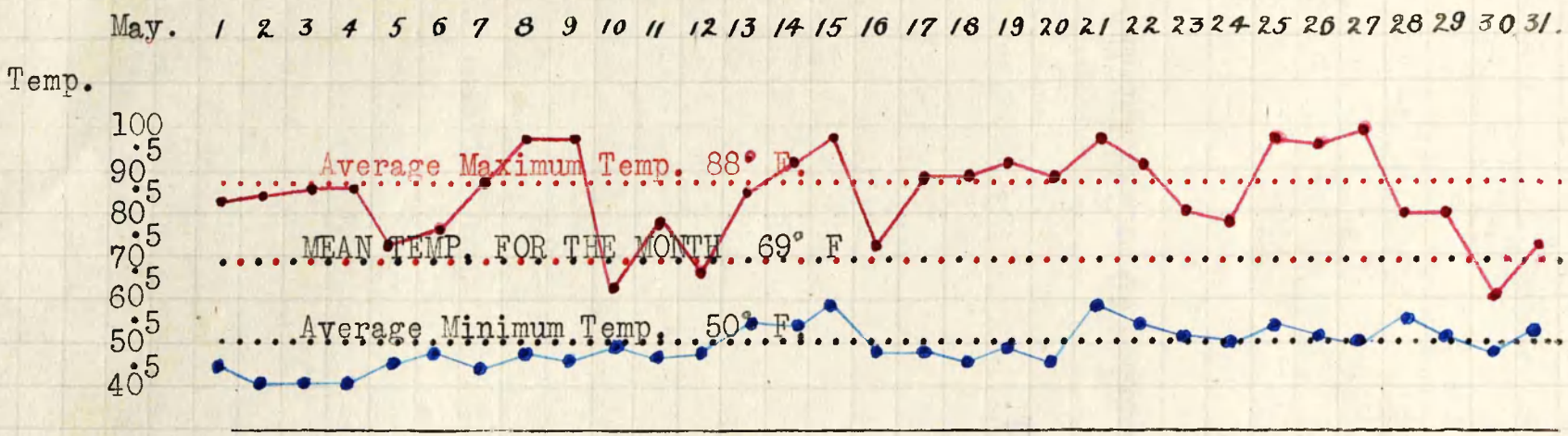
It is the external factors, however, that influence the life history of the mosquito, that determine the greatest variation in the prevalence of Malaria, according to climate, season, temperature, altitude etc..

Climate. It is generally accepted that the incidence of Malaria increases as we approach the equator, and the areas of greatest intensity are those in which we get the combination of heat and moisture. Exposure to heat of the tropical sun is sufficient in many cases to induce sporulation of the parasite in Latent Malaria.

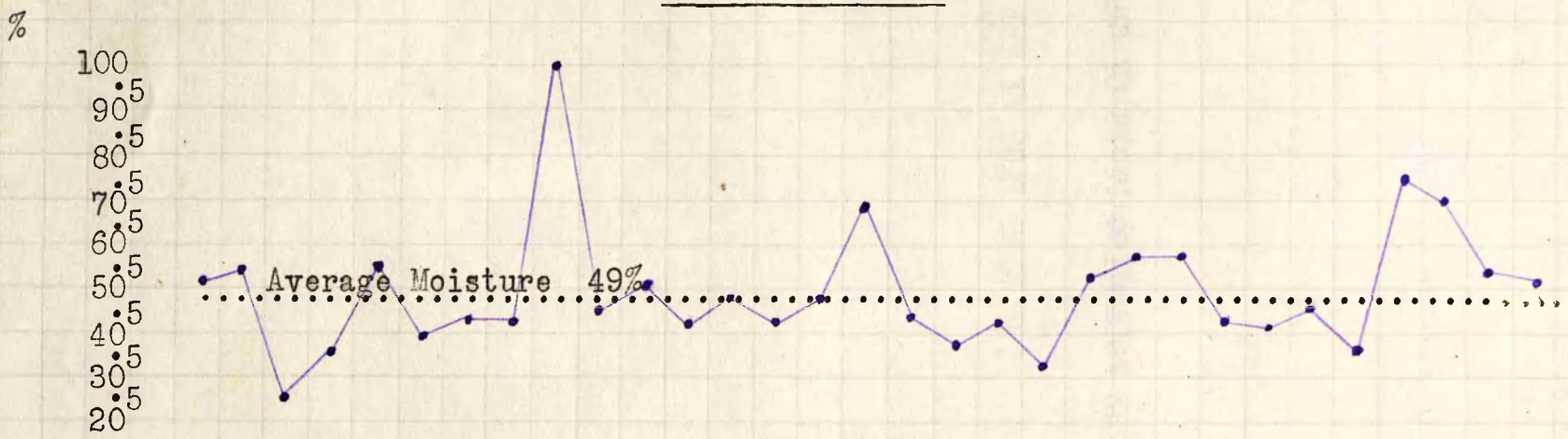
With regard to latitude, Hirsch gives the line of demarcation in the northern hemisphere. The line starts at 55deg. N. on the western side of N. America, sinks to 45deg. N. on its eastern side, rises again to 63deg. or 64deg. on the western side of the old world (Sweden), and runs across North

THE FOLLOWING PAGES OF CHARTS REFER TO MATTER TREATED IN THE NEXT PAGE OF THE TEXT.

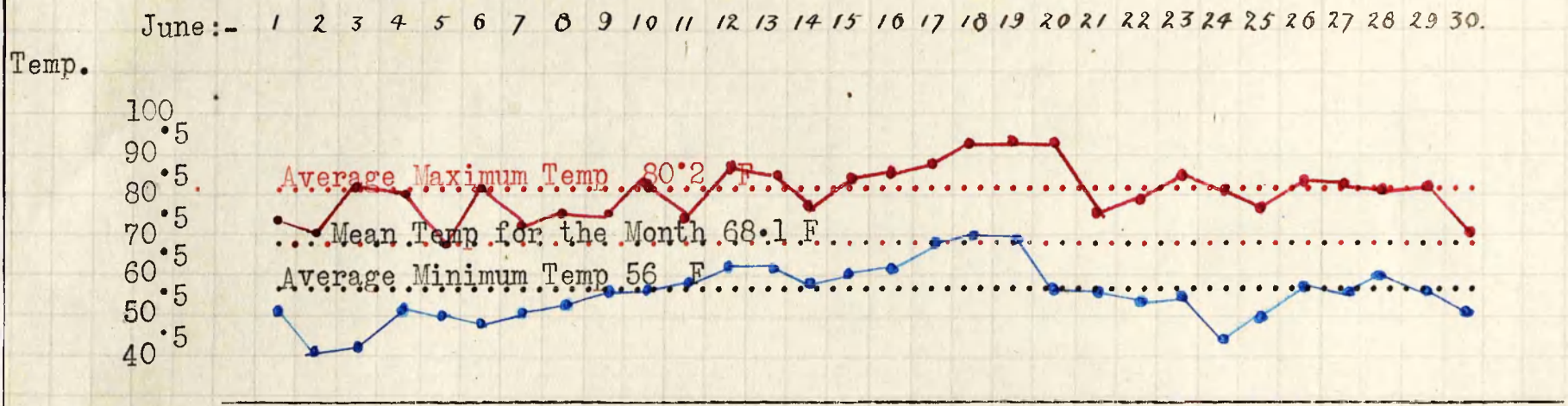
Max. & Min. Temperatures Chart. MAY 1918.



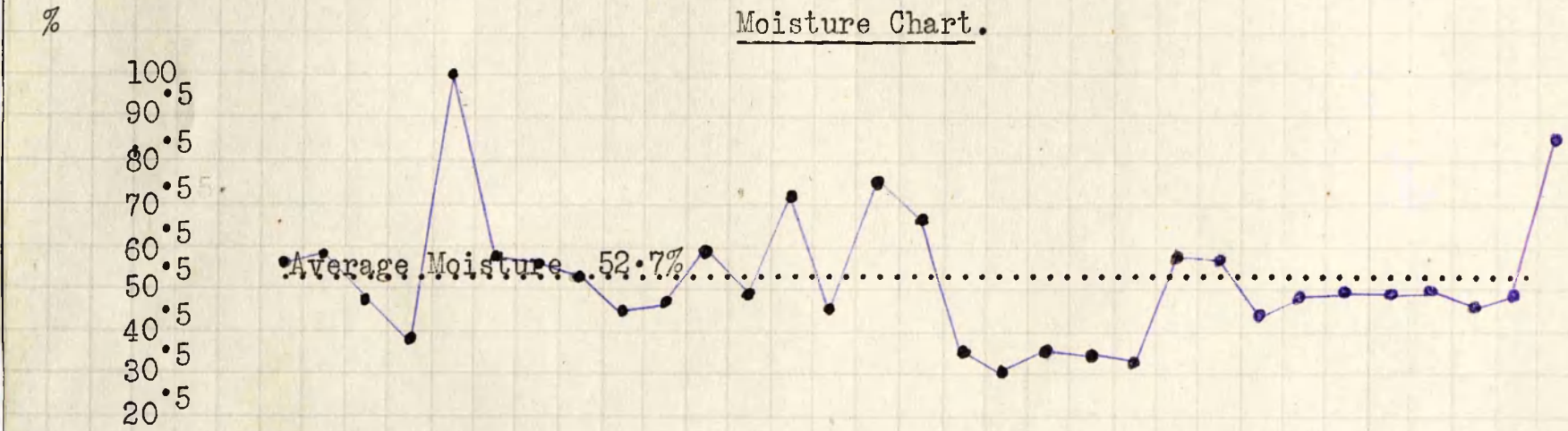
Moisture Chart.



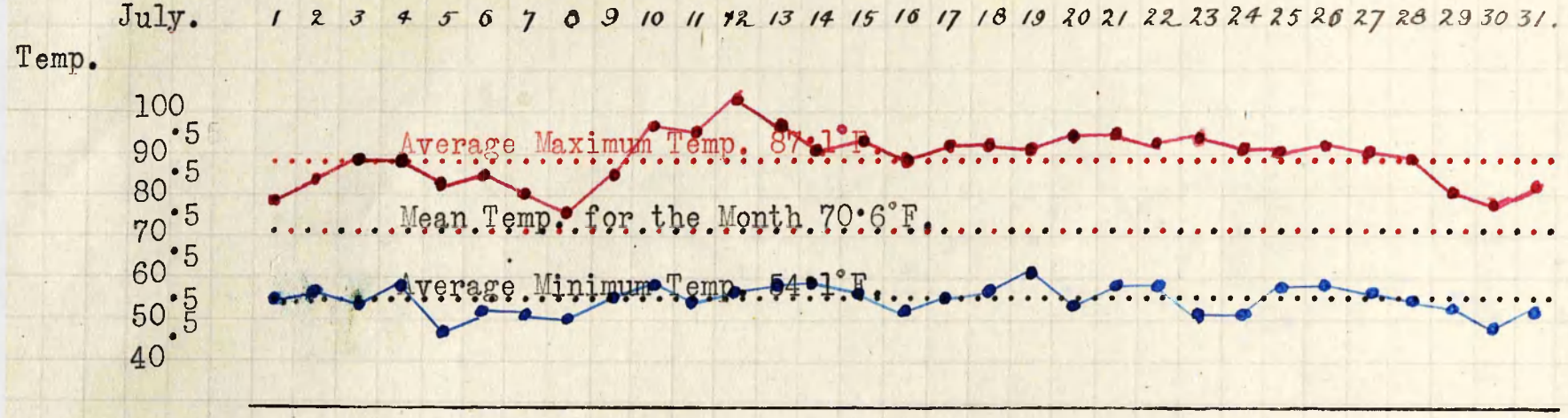
Max. & Min. Temperatures Chart. JUNE 1918.



Moisture Chart.



Max. & Min. Temperatures Chart. July 1918.



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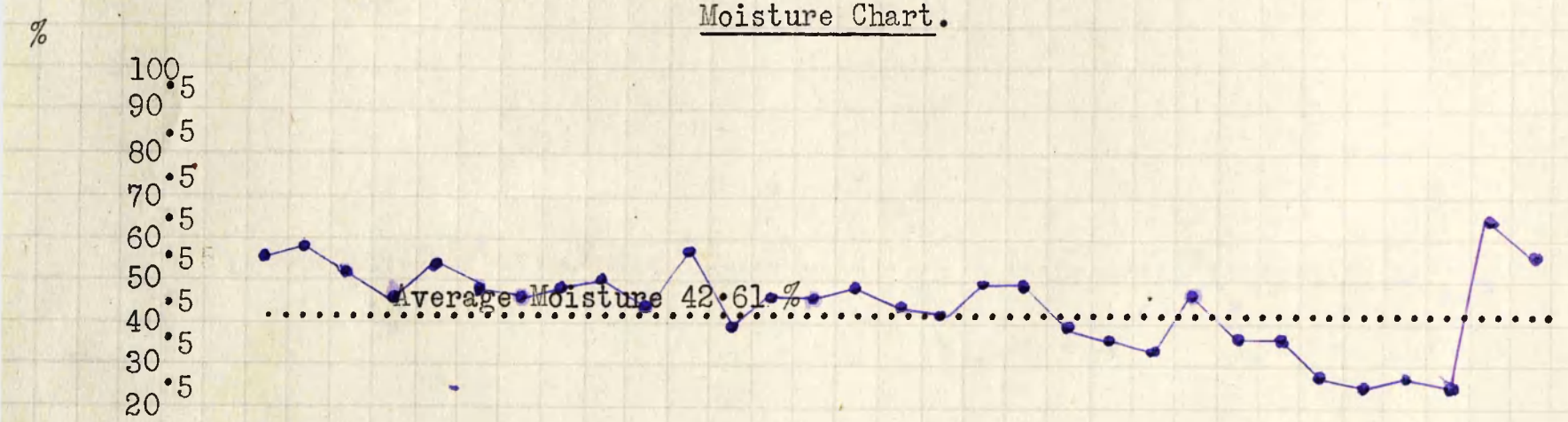
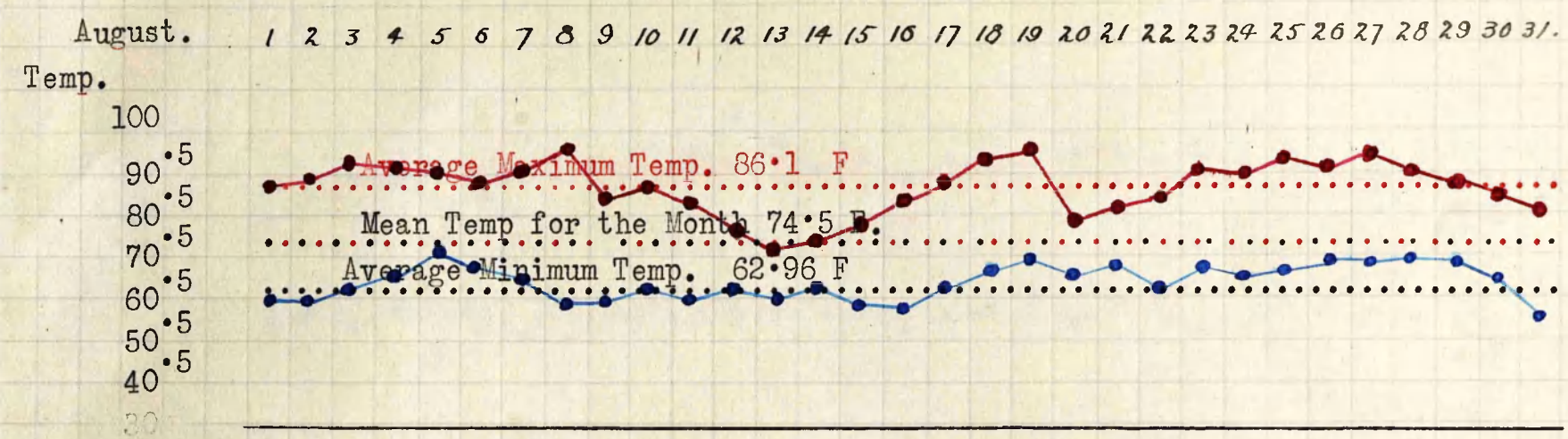


Max. & Min. Temperatures Chart. August 1918.



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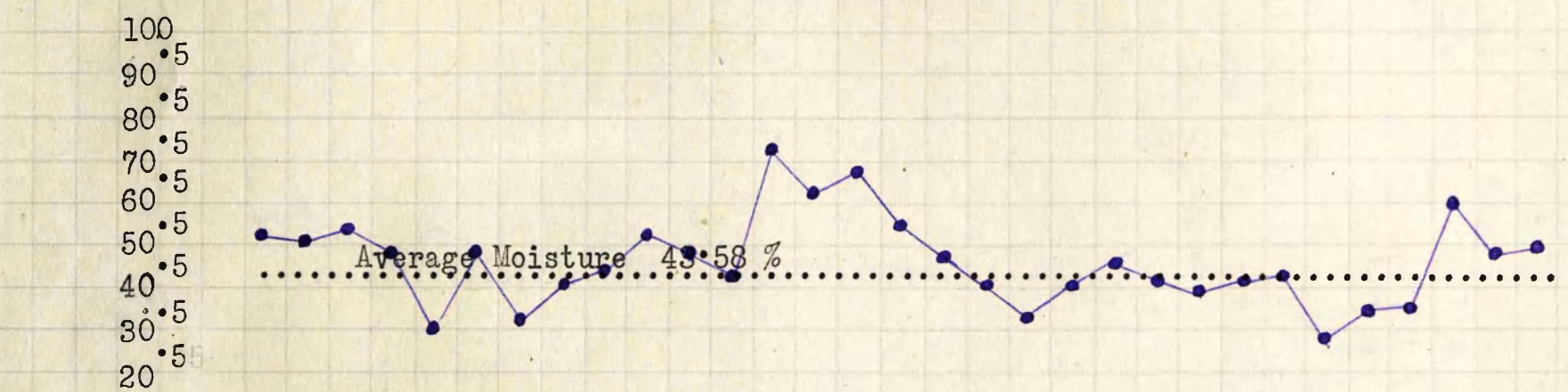


Asia in about latitude 55deg N..

Even before Malaria became known to be connected with mosquitoes,it was realised that the disease was not endemic unless the summer temperature maintained a certain average. Drake,in America,stated that an average summer temperature of 60 deg. was necessary for the existence of Malaria. This is certainly borne out by the records of temperature made by me me during the summer of 1918. The charts of Maximum and Minimum temperatures for the months of May,June,July,and August of that year are shown opposite this page. It is a matter of regret that the records for September and October are not available, but as these months were otherwise taken up - September being the month of the break through of the Bulgarian defences,and October that of travelling through Bulgaria,Serbia,and part of Roumania and Turkey - it was impossible to keep the records. It will be seen that the mean temperature shewn for the month of May is 69deg Fahr.,for June,68 deg Fahr. - exceptionally cold for that district at that time of year - ,July 70·6 deg. Fahr.,and August 74·5 deg. Fahr.. Each of these mean temperatures however agrees with the minimum laid down by Drake. He also points out that 60 deg. Fahr. is the lowest temperature at which the parasite will develop in the body of the mosquito.

I may point out here,that the temperatures given in the tables are all shade temperatures,taken at an altitude of 600 metres. It was at this altitude that all the tables given were

compiled,and are representative of that area,and are therefore comparable,the one with the other.

Season Relapses of Malaria may of course occur at any season,and in certain tropical areas fresh,or primary infection may take place during any period of the year;in temperate and sub-tropical regions there are definite seasons during which the disease is specially prevalent. This is the "Malarial Season",and varies according to latitude,temperature,rainfall, soil,etc.

The season of primary attacks - from which the "season" is really calculated - depends upon the life history of the malarial mosquito. This usually begins about three weeks after the first broods of Anopheline mosquitoes appear. This statement must however be made with certain reservations,as there may be isolated cases of winter breeding which have little or no effect upon the commencement of the full blown "Malarial Season" of the district. I refer to such instances as I have found myself existing in the Struma Valley. At Nigrita,close to the river,are hot springs,with numerous pools collected around. These maintained a temperature varying from 96 deg. in the centre,to freezing point (in the winter) around the periphery of the area - in all about one hundred and fifty metres diameter. Here,while snow was lying all along the valley, and the margins of the Struma River were frozen and all marshes frost-bound,I found Anopheline larvae in some of the pools in full vigour. This I regard as an exceptional case,having no

MOSQUITO COUNTS.

Date 1918.	Total	Culex		Anophel.		Super-Pict.		Others.	
		No.	% .	No.	%.	No.	%.	No.	%.
June. 1.	Only a few of various species caught during this period.								
8.									
15.									
22.									
29.	46	44	95.6	2	4.4	-	-	-	-
July. 5.	57	26	45.6	31	44.4	-	-	-	-
13.	107	18	16.8	88	82.3	-	-	1	.9
20.	90	11	12.2	78	88.7	1	1.1	-	-
27.	128	16	12.5	111	86.7	-	-	1	.8
Augt. 3.	134	12	8.9	121	90.2	1	.9	-	-
10.	178	14	7.8	155	87.6	4	2.2	5	2.4
17.	520	97	18.6	409	78.6	13	2.5	1	.3
24.	360	54	15.0	295	81.9	9	2.5	2	.6
31.	390	64	16.4	312	80.0	11	2.8	3	.8
Sept. 7.	280	134	47.6	140	50.0	4	1.6	2	.8
(12.	470	251	53.4	131	27.8	81	17.2	7	1.6)
14.	180	120	66.6	34	18.8	25	13.2	1	.8
21.	218	160	73.3	23	10.5	32	14.6	3	1.6
28.	120	87	72.4	12	10.1	21	17.5	-	-

effect upon the definite Malaria season in the valley. In other parts,I found vigorous Anopheline larvae in certain sheltered Turkish wells as early as the first wekk of April. It is not till the latter part of June that Anophelis is found breeding in sufficient quantity to enable one to say that the Malarial season has begun.

The table opposite shews the result of observations carried out in the area mentioned and gives the weekly dates of differential counts,shewing the percentage of the different mosquitoes caught. These figures are taken from the numbers caught in one set of hospital marquees by the same orderlies, and under exactly the same conditions,therefore the element of human error will be constant throughout. The weekly counts were made by me,and the result is an analysis of the mosquito life during the period from June 1st,to September 30th,the last month being completed for me by a trained and experienced orderly.

It will be seen from the table that the acme of Anopheline breeding has taken place towards the end of August,and one would expect that the largest number of primary cases would be about the latter part of September. This was found to be the case, and is borne out by the admission rates to the General Hospitals at the Base,Salonika. As of course,I myself could not be both up the line,and at the Base,I give the following numbers of cases under treatment at the 28th. General Hospital,as com-

piled by Capt. Alport,to whom I am indebted for the figures.

		Malaria				
May.	1917.	Admitted	487	= 51.1 %	of total	sickness.
June	"	"	479	= 33.5 %	"	"
July	"	"	694	= 66.8 %	"	"
August	"	"	1295	= 78.1 %	"	"
Septbr.	"	"	1523	= 81.7 %	"	"
October	"	"	1530	= 78.4 %	"	"
November	"	"	865	= 72.3 %	"	"
December	"	"	1010	= 66.01%	"	"

These figures,it will be seen,coincide with what might be expected from the previous table of mosquito breeding. The sudden increase in the December admissions is undoubtedly due to the increasing cold which sets in usually suddenly in the latter part of November. It is the rule for the weather to change suddenly about the 20th of this month,from the heat of the "Indian summer"to the other extreme of almost arctic blizzard, which,needless to say,brings out in a very large number of cases Malaria which has been latent.

It will be observed from the table of 'Differential counts'that the number of "Superpictus Bifurcatus" increases more or less steadily in the later part of the season,reaching the zenith in September. This is an interesting feature,as in Greece,the popular belief is among the natives,that this is the mosquito which gives the 'pernicious' infection. This may,or may

not,be the case,but the fact remains that the largest number of these cases is found to be in hospital during the early winter months. This was found to be the case by Capt Alport, through whose hands passed practically all the cases evacuated by ambulance train from the Doiran front.

From the particulars given here,one may safely state that the Malarial season in Macedonia extends from,at the earliest,May,till at the latest November. These dates are fixed by,firstly,the prevalence of the Malarial mosquito during these months,and,secondly,from the admission rates of the General Hospitals at the Base.

In conclusion,I may mention that the other types of mosquito met with in the region are the ever present Culex, which,while not in itself Malarious,amounts almost to a plague so widespread is it. They are found from as early as April, right on through the season till actually killed in the winter by the cold. Even during the winter months,this mosquito may be found hibernating in the dark,badly ventilated,but warm houses of the natives,waiting to re-emerge on the advent of warm sunny weather to propagate its species,and continue to make itself,and the country-side generally intensely unpopular. Included in the last column of the table,headed 'others' is chiefly 'Theobaldia',a type of mosquito which is not credited with carrying Malaria.

Rainfall. Rain has a twofold effect upon the prevalence of

Malaria. Firstly,exposure to wet is frequently followed by a recrudesence of a former infection. This effect is,of course, practically immediate. Secondly, rainfall produces breeding pools for the mosquito. This result is not shewn immediately,as it takes several weeks before the mosquitoes breed out. If the rainfall be excessive, as it frequently is during the almost tropical thunder-storms,then it has a beneficial effect for the time being,as it washes out all breeding pools,resulting in the destruction of a large number of the larvae,but even then it leaves behind it many pools which are very soon filled with a fresh stock,as during the breeding season,the mosquito does not miss many opportunities of propagating her species.

As one would expect,moderate rain at frequent intervals is more conducive to mosquito breeding than downpours at longer intervals.

During the months of May,June,July,and August,1918,I took wet and dry bulb readings,and calculated the relative humidity daily. On the pages preceding and facing page 15 will be found the tables compiled giving these. It will be seen from these tables that the average percentage of moisture for May was 49, June 52.7 %, July 42.6%,and August 43.5%. It will thus be seen that we have the necessary combination here,of heat and moisture for the production of the full grown mosquito. I do not say that the relative humidity of the atmosphere has any direct bearing upon mosquito breeding,but I hold that there must be a large

amount of ground water present to give this amount of humidity, and therein lies one of the chief factors in the life of the mosquito. In the table of 'Moisture' one may take all the days on which there is shewn a sharp rise above the average line, as being days upon which there was rain - in most cases thunder-storms, as proof of which, it will be found that in practically every case it was followed by a drop in the temperature.

As mentioned in the introduction, in the valley of the River Struma, the ground water level is high, and as a result any hole, or considerable hollow, is likely to contain water, and as an almost inevitable result, mosquito larvae. Each trench, shell-hole, and often gun emplacement, became if not actually, at least potentially, an incubator for the unwelcome visitor, and had all to be taken into account in the anti-malarial measures of which I shall speak later.

Soil. The character of the soil has a relation to the breeding of malarial mosquitoes, only in so far as there may be any salt in it soluble in water, which may then render pools of standing water noxious to mosquitoes or even toxic to the larvae if eggs be deposited therein. The physical conformation of the ground has more bearing upon the breeding than the geological characteristics of the soil itself. Clay soil retains the moisture better than a porous sandy soil, and, provided it can retain it long enough to outlast the aquatic period of the larval life, fulfils

the necessary function as a breeding place. Pools upon a rock bed are very persistent,and by conducted heat,can give the necessary data for rapid evolution. In some of the mountain streams, one finds during the height of the breeding season,rock-bound pools,which become stagnant or have but a trickle of water in and out of them,with a scum of green algae spread over their surfaces. Here is par excellence,the ideal breeding pool of the mosquito. One can even now picture such a pool,with overhanging foliage, boiling with "wrigglers" in the water,and the surface a misty haze composed of adult mosquitoes,carrying on their nefarious duties,while the air is filled with a not unmusical hum of their wings,or,as has been pointed out,by Dr. Darling of the Panama Zone Commission,of their probosces!

Topography. A flat low lying country,with sufficient heat and moisture,is ideal for breeding mosquitoes. In such a country,one can imagine hills and knolls rising up as islands on the plain. Frequently it is found that in circumstances such as these, that the plain is highly malarious,while the hills are free. This may arise from a variety of causes. Low marshy swamps,lake sides,low coast levels,and river valleys are usually typically malarious. In these one generally finds the rivers and streams flow very sluggishly,and have a large amount of weed in them, and overgrown banks,giving ideal conditions for larval life. If on the other hand, the slope of the ground is sufficient to give the stream enough impetus to flow more rapidly,there is less

liklihood of breeding taking place to anything like the same extent. Again the question of prevailing wind has a distinct bearing on the question. The 'knolls' mentioned above frequently stand up into a steady current of the prevailing wind, like a rock standing up in the bed of a stream, and frequently it is found that this is sufficient to prevent mosquitoes inhabiting them. I know of one very marked case of this in the Struma Valley, opposite Rupel Pass, on the south side of the valley. Here stands a sugar loaf hill, rising to a height of about 250 metres. This was used as an observation post. On this hill it was exceptional to find a mosquito, though all around its base they were swarming in millions. I attribute this to the fact that there was a constant current of air around this mound, and the mosquito dislikes wind intensely. I shall deal with the influence of wind upon the prevalence of Malaria more fully later.

Altitude. This question is intimately connected with the last paragraph upon topography, and is in fact another phase of the same question. It is taught in all books on Malaria that it is a disease of low swampy countries, and, whilst they do not state that it is confined to these, they leave that inference. My own experience in Macedonia brought me very forcibly to the conclusion that it also existed at various altitudes. My statistics bear chiefly upon the incidence of Malaria and malarial mosquitoes upon a plateau situated 800 metres above ordinance datum.

As has been pointed out,the temperature and moisture present at this elevation come within the limits set down by Drake, and these,I hold,are the governing factors in the etiology of Malaria, more than the actual number of metres of altitude except in so far as that governs the prevailing temperature. It would thus appear that Malaria may be found at increasing altitude as one approaches the equator,so long as the moisture necessary for the aquatic phase is present. This,I think is sufficiently proved to be the case,from the fact that in Sierra Leone,and again in India,Malaria is found at considerable altitudes, in the former case at a height of 1550 metres,and in the latter, 2000 metres. I suggest that the term 'altitude' be used relatively to the immediate neighbourhood as it is often found that a few metres of rise – e.g. into the foothills along a valley – may give more immunity from attack than as many kilometres of latitude.

Inundation. This has a distinct relation to Malaria,as,after a flood,there are of necessity left behind many pools,where, if they persist sufficiently long enough,mosquitoes will breed. The immediate effect of inundation is to check temporarily the development of Malaria,through the destructive effect upon the larvae existing at the time,and the washing out of ditches,pools, canals,etc.,but ere long the last condition is many times worse than the first,and the attack rate of Malaria shortly shews a

tendency to rise.

In the Struma Valley,and also the Vardar Valley,and around the various lakes mentioned at the beginning of this paper,large tracts of flat country are liable to inundation at certain periods of the year,and this bears an important relation to the incidence of Malaria in these respective districts. As will be gathered from the moisture charts,the atmosphere carries a considerable amount of water even during the hottest part of the year,hence the pools do not dry up very rapidly,and sufficient time is given for at least one brood to develop from each and many of these pools persist throughout the season,and are a perpetual storehouse to replenish the stock of mosquitoes against all attempts at their destruction.

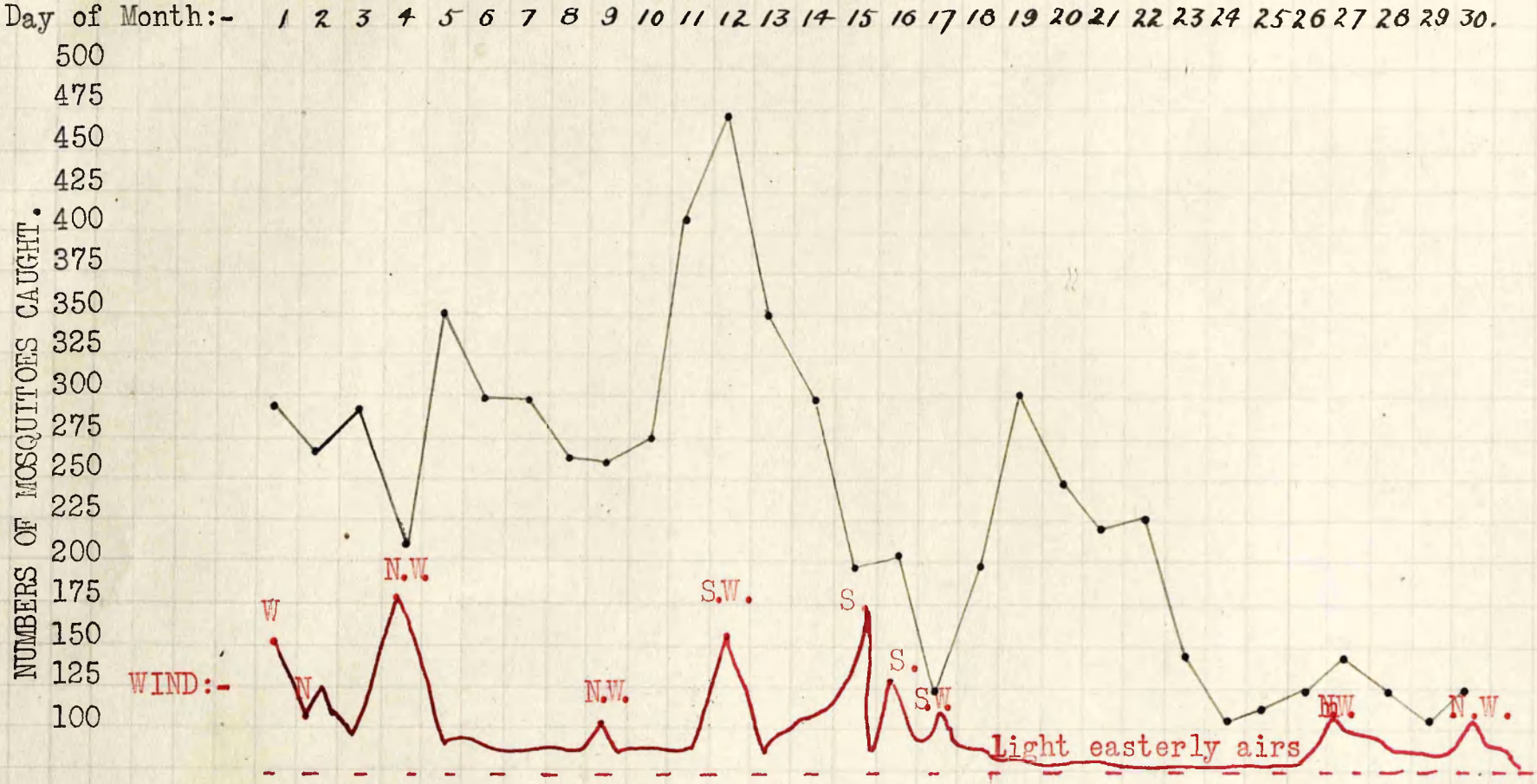
Trees and Vegetation. At one time it was presumed that the presence of trees militated against malaria. So much so was this that at one time,in the days of ancient Rome,trees were protected by law,This is now however seen to have been overestimated. Trees prevent the sun getting at the soil,and so drying it up as it would otherwise do. They also provide shade for the mosquitoes,which is necessary for all types,and more particularly so for the Anophelis Maculipennis,the chief type in the Balkan Peninsula.There are few densely wooded areas in Greek Macedonia as one understands them in this country. Almost everywhere the ground is covered by scrub,in which the mosquito rests during the day. A walk through this will raise clouds of them,which

rapidly subside when the disturbing influence is removed. In the anti-malarial measures adopted amongst the troops, this scrub was regarded as one of the chief dangers, and was dealt with accordingly. Vegetation was apt to be particularly rife in the vicinity of moist and marshy places, and in the neighbourhood of pools and streams, and had its own part to play in the protection and feeding of the mosquito and its larva. On the whole, working amongst the conditions mentioned, one quickly came to the opinion that the less scrub and vegetation, the greater the chance of reducing the number of the mosquitoes.

Wind. Wind in relation to altitude has already been dealt with and no more need be said of it in this sense. I propose now to deal with it in relation to transmission of mosquitoes from a distance. In olden times wind was blamed for carrying Malaria for very long distances. It used to be stated that Italy became malarious through the agency of the African Sirocco. Authorities state now that wind has very little effect upon transmission of Malaria for any appreciable distance. They point out that, Anophelis, being a weak flier, seeks shelter during a breeze. This I have already mentioned, but I conducted a series of experiments bearing upon this subject, and state some of the results here. During the early summer of 1918, the unit with which I was stationed was camped in the centre of the plateau previously mentioned. Antimalarial work had been carried out on an extensive scale for several kilos in every direction.

DAILY NUMBER OF MOSQUITOES CAUGHT NEAR UNTREATED AREA.

September 1918.



Numbers of Mosquitoes caught shewn BLACK. Direction & Volume of Wind shewn RED.

Effect of WIND in carrying MOSQUITOES.

FLY-BAND EXPERIMENT.

Date 1918.	Direct of Exposure	Total Insects	Approx. % Mosquits.	Chief Types.	Dir. of Wind.
Sept. 2nd	N.	24	60%		
(Dull & Dry).	S.	7	71%		
	E.	14	72%	Anophelis Maculi-pennis	N.
	W.	18	74%		
Sept 12th.					
(Fair & Warm).	N.	8	68%		
	S.	48	78%	A.Maculipennis &	
	E.	6	70%	A.Superpictus.	S.W.
	W.	52	76%		
Sept. 19th	N.	6	75%		
(Fine).	S.	8	68%		
	E.	4	75%	Do. Do.	Light variable airs.
	W.	28	75%		
Sept 27th.					
(Fine & cold).	N.	5	60%		
	S.	2	50%		
	E.	3	33%	Do. Do.	N.W.
	W.	7	71%		

The incidence rate of Malaria in that site at that time was not five per cent. Suddenly the unit was moved to another site just on ths western edge of this treated area,and immediately the incidence rate was more than doubled (11%). The nearest untreated part was not more than half a mile away,and situated to the west of the camp. Daily counts were made of the mosquitoes caught,and these were charted,also the direction of the wind on the respective days was shewn.The results are shewn on the pages opposite.

As an additional experiment,I fixed 'fly-bands' with the adhesive surfaces facing fixed directions. In order that these bands should not entirely break the currents of air,and cause eddies,I punctured them liberally with holes,so that the air could escape through them. Table "Y" opposite shews a few of these results chosen for respective directions of wind. As there was no prevailing east wind in this situation,on account of the topographical character of the district,no definite results could be obtained for that wind. These figures, though they prove nothing,tend to shew that the mosquitoes could be carried at least half a mile in considerable numbers, by the prevailing wind. One can imagine a mosquito attempting a flight during a light wind,and while actually it <u>flies</u> say thirty or forty yards,it may be carried along with the wind for five or six times that distance,before it descends to drink or feed again. This fly-paper experiment could not be carried

out very extensively owing to the nature of the substance employed,and the inquisitive and acquisitive propensities of the children from a neighbouring village,who regarded these 'bands' as a new form of sweetmeat,with disastrous results to both the experiment and themselwes !

Race. As a general rule,it is accepted that the black races are less susceptible to malarial infection than the white. This statement requires,I think, some qualification. If one could get,say,half a dozen adult negroes,who could be proved never to have had exposure to malarial infection,and also the same number of white adults,collected under the same conditions and place the whole dozen in the centre of a malarious area,all exposed to exactly the same risks,I have little doubt but that the attack rate would be at least equal in both colours,if not less among the whites. The latter I consider quite possible,as general hygiene would be sufficient to turn the scale in their favour. The point of racial immunity is,I think,purely a relative one. When an examination is made of black people (adults) living in a malarial area,and a certain ratio of affected persons arrived at,this can seldom be compared with an adult community of white people who have lived their lives in a malarial area under conditions similiar to the blacks.The comparisons thus made are not strictly speaking,comparable at all. The fact of the matter is that the selection of the fittest among the black people is made in childhood,and those that survive to adult

life are really those that have acquired more or less immunity.

The medical statistics of the French colonial troops for the year 1903 give the following figures for French West Africa, European troops,7.5 per thousand of the effective force, Negro troops 0.3 per thousand. During the campaign in the Balkans,I know that the mortality amongst the French colonial troops was very heavy,though I am not in a position to give the actual figures.

It would seem that the negro,if removed from the infection,amidst which he has been reared,is practically as liable to another infection as his white brother. I beleive that "immunity" is acquired by repeated infection,especially in children,and by prolonged residence in a malarial region - a sort of acclimatisation - because this "immunity" is much more to be found in adults than in children; that it is often diminished by a change of residence, or may be even lost by a temporary residence,in a non-malarial climate;and that in an individual,it may exist to one form of malaria,and not to another.

I do not think it necessary to enlarge further upon this point,except to sum up that the immunity of the negro is purely a relative one,and the result of earlier attacks,and not to be attributed to hereditary causes.

Sex. Statistically females are less prone to malaria,than males,but this I think is principally due to the fact that as a general rule they are less exposed to infection. I do not see

that there is any possible reason why women should be less susceptible,and figures do not show this where the exposure of the sexes is equal. In Panama,there is said to be very little difference between the sexes.In the Dutch East Indies,European women are more susceptible than men. Between the years 1871-1875 the death rate of soldiers wives in India was 4·2 per thousand, as compared with 2·81 for the men. In Macedonia,whilst I held the daily sick parades for a female labour batallion,the attack rate of females was equally heavy to that in male batallions, and in one instance,that of a female anti-malaria squad,the incidence was certainly heavier than that of another male squad working in the same locality,and under the same conditions.

Age. Children are more severely and more frequently attacked by Malaria than adults.This is due to several causes,e.g.,more delicate skin,type of dress (or undress),sounder and more prolonged sleep - often in the open - and less ability to defend themselves from mosquito bites.

Whilst working medically amongst the Macedonian natives, I took every opportunity of examining the spleens of children, and it was exceptional to find a normal case.In that area, it would appear to be that in childhood,each person runs the gauntlet,and either dies or recovers,carrying from that stage a certain degree of what I have classed "relative immunity". Certainly the death rate amongst children is large,and is looked upon by the natives as "fate",and evinces little more than the

omni-present shrug of the shoulders,which is the native way of expressing'it cant be helped'.

Other Factors. Certain factors not previously ennumerated have a bearing upon the etiology of Malaria,and before the truth of this infection was fully realised,were often blamed as the causative factors of the disease.These are:- overwork,fatigue, exposure,(whether to wind,sun,or rain,) excesses of all kinds, loss of sleep,hunger,thirst,and the administration of certain medicaments such as Potass. Iodid.,which has been blamed for causing Paludism.

At this date,I think it is obvious that the effect of these factors is only upon latent malaria, or the parthenogenetic cycle of the parasite's history.

I have now,I think said sufficient upon the etiological consideration,and will now proceed to the discussion of the treatment,both prophylactic and curative,chiefly the former, as,having been in charge of the anti-malarial work of the area most of the time,I had more opportunity of observing the former phase,than the latter.

TREATMENT.

(a). Prophylactic. As has been pointed out previously, the disease Malaria depends upon the life history of three animals Man, Mosquito, and Parasite. A break in the chain of sequence at any part must therefore shew itself by the cessation of Malaria. As the aim is to prevent the destruction of man, then it must resolve itself into the destruction, as far as possible, of either, or both, of the other two. I therefore propose to deal with the subject under these headings.

Laveran's discovery went very far towards elucidating the diagnosis of Malaria, and Ross's as far towards the prophylaxis. The latter, though still comparatively recent has already been instrumental in saving untold suffering, and many lives. Prophylaxis may be conducted by a community or an individual, and may be offensive or defensive. It is only by the combination of these that the full results cam be hoped for. In some areas, unconscious prophylaxis has been carried out

(i) In the process of reclamation of swamp ground for agricultural purposes, the clearing and cultivation of land etc.,

(ii) By improved hygienic conditions, better homes and food, installation of water supplies and sewerage schemes, better road and street surfaces etc.,

(iii) More cases of the fever cured by the use of Cinchona - even before the origin of 'malaria' was appreciated, and

by these means lessening the number of cases of latent malaria, and thus diminishing the sources from which parasites might be obtained.

For very few other diseases has unconscious prophylaxis done so much as in the case of malaria. With these tediously attained,and often incomplete,results of this form of prophylaxis,are in marked contrast the results of organised and vigorous sanitary measures such as have been previously indicated in the case of the Panama Canal zone. Another striking example is Ismalia,near the middle of the Suez Canal. This town, of about 8000 inhabitants,was founded in 1862, and remained healthy till about 1877,when Malaria was introduced,and spread rapidly. This condition continued till in 1902,Ross,MacGregor, and Pressat conducted a survey of the conditions prevailing. Work was immediately begun on an organised scheme,and rapidly bore fruit. From 1885 till 1902 the average number of cases per year was 1800. In 1903,there were 214 cases;in 1904,90 cases; and in 1905,only 37. Similar results were obtained in the Federated Malay States,when the mortality was reduced from 295 in 1900,to 45 in 1905.

Sufficient has been said to shew that organised schemes must be the accepted method,if ever malarious districts are to be made healthy. Considering the fact that the death rate of the Isthmian Canal zone,at one time the most insalubrious place on the face of the earth,has been reduced till it does not

exceed that of New York City,what excuse is there for not dealing with other similar areas,and so eradicating this disease that saps not only the vitality of the individual,but the very life-blood of the nation?

1.MEASURES FOR THE DESTRUCTION OF THE MOSQUITO.

Destruction of all breeding pools must be the key-note of all anti-malarial measures,as it has been in all the historical cases. It is not possible,nor even necessary,to remove all surface water from a malarial country,but only in the neighbourhood of inhabitations, or where Anophelines are known to breed habitually. In the Panama campaign,the area of mosquito destruction was limited to two hundred yards. This should certainly be the minimum distance. In the anti-malarial campaign in the part of the Balkans occupied by our troops,three hundred yards was taken as the minimum,and even then,as shewn in the discussion of 'wind' it was found that mosquitoes were blown from the untreated zone into the treated,though not in excessive numbers, yet one infected mosquito may cause several cases of Malaria.

The first step in preventive work should always be the removal of all scrub and undergrowth,for a double reason. Firstly,in this the mosquito rests during the day,ready to sally forth at night; secondly,it shews all collecting places for water which might easily be hidden under the growth. Let me point out here,that one need not set out to search for large

pools and holes,to the exclusion of small reservoirs,as I know of a case where a jam tin in the neighbourhood of a camp kept one part of it well supplied with mosquitoes! Nothing that can hold water is too small for treatment. I made it a rule throughout my antimalarial work that every tin,whether bully beef,cigarette, or any other kind of tin,was to be punctured in several places as soon as emptied. This ensured that they, at least would not hold water,or harbour mosquitoes.I was led to this course as the result of inspection one day in a camp. In the neighbourhood of the cook-house was a collection of tins,which had been through the incinerator,and were waiting to be put into a cook-house soakage pit. They had lain there for about fourteen days. Every second tin had water in it,and in each collection, there was a wriggling mass of Anopheline larvae. Yet the Medical Officer of the unit wondered why he had so many mosquitoes in his camp,notwithstanding the fact that he had had his anti-malarial squad doubled,and had treated all ravines and pools for three hundred yards round the camp.

Water-barrels,tanks,cisterns,fire-buckets,etc., must be well protected. If practicable,a very simple procedure may be adopted. In the army,fire buckets which had to be kept ready filled at all times,were found to be prolific breeding places. Oiling of these was forbidden for obvious reasons. The rule was made that these should be emptied on the ground (where the water rapidly dried up) and refilled at least once a week,

preferably twice. Thus development of each crop of larvae was prevented,and they rapidly perished when spilled on the ground. One of the chief troubles in the army camps was the fact that water had to be obtained somewhere near the camp for watering horses.In these artificial ponds one was continually finding larvae,and these could not be oiled,as,even though an average horse would drink the water,the mule,which was usually the commoner of the two,was much more particular. Where possible, these ponds had to be made with a flushing dam,which could be opened at some part of each day,leaving the pond empty and exposed to the sun for as long as possible. This was found fairly efficacious,but unfortunately,could not always be carried out,owing to scarcity of water.

Wells were also a difficult problem. As already indicated,these exist almost everywhere in profusion and are prolific incubators of larvae,particularly of Anophelis. I observed at the time,and find it confirmed by the authotities on the subject that Anophelis is much more particular as regards the type of pool etc.,in which it breeds. I cannot say whether the discrimination rests with the egg-laying insect,by which she avoids certain pools,or whether it is that the eggs failed to develop in some,but the fact was very obvious that only in clear and comparatively fresh water would one find Anopheline larvae, mixed certainly with some Culex. On the other hand, in any old

muddy pool or hole full of stagnant water,one could always find Culicine larvae. Fortunate it is for man that it is the Anophelis and not the Culex,that carries Malaria in the Balkans, for there the Culex is much hardier,appears months earlier,persists much later,and can find habitat where Anophelis certainly cannot flourish.

The treatment of streams is a comparatively simple and straightforward matter as a rule. If the stream is rapid flowing, then it is not likely to be a breeder. Pools,particularly if rock-bound,must be searched for and dealt with. All overhanging trees and scrub must be cut,so as to let the sunlight in. There is nothing that the mosquito hates more than sunlight,and the mere fact of sunlight playing upon the surface of a pool acts as a deterrant to her laying her eggs therein. The larvae also object to too much sun,and are found in largest numbers on the shady side,or at least in the shelter of the banks.Where the stream is sluggish,it is likely to be overgrown with rank growth and full of algae, Here it is that the mosquito flourishes, and here the chief work of the anti-mosquito squads lies. All weed must be cleared away,and this at regular periods,as it rapidly accumulates and re-forms. For this purpose we made brooms of the scrub which had been cut,and swept the streams at periods of not more than three days. Having cleared the banks of growth and the bed of weed,the banks were cut straight,so as to give a clear run for the water. Where possible,especially if the

stream were shallow,the sides were filled in,barring a 'V' shaped channel for the water,thus confining its area, and thereby increasing its velocity. The sides were built up of stones,large enough to withstand a rush of water. By this means,straggling weedy streams were converted into narrow runners,with straight runs and greater speed,thus eliminating the essentials for mosquito breeding. These measures were found very efficient in attaining the object in view,namely the abolition of mosquito breeding,but unfortunately were not permanent enough. In the Balkans,there occur at frequent intervals,especially in the autumn,violent storms,cyclonic in character.The small runner becomes in a few minutes a roaring cataract,sweeping away in seconds what had taken weeks to produce. Whilst watching such destruction of labour,the only satisfaction was that the larvae were also being swept away to destruction,but even this satisfaction was tempered by the fact of the knowledge that they would be replaced quicker than the measures to meet them.
The permanent form of channelling should be done in cement, so as to prevent washing out. All junctions should be made inclining towards the direction of flow,and never at right angles.
The side opposite any junction should be made higher than elsewhere, so as to prevent overflow.

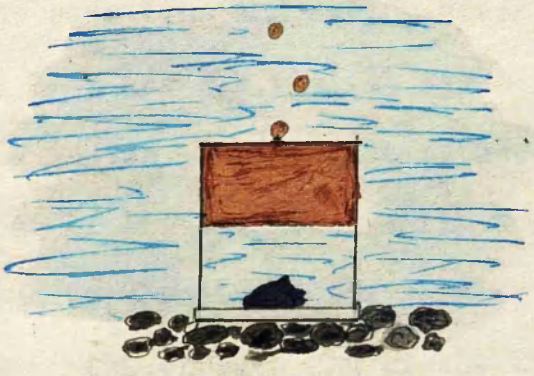
While trimming and channelling are good,they,unfortunately cannot always be carried out.There are some pools,chiefly

rock-bound,where these measures cannot be carried out,and the only form of treatment is that I propose to deal with next_ oiling.

As is now fully recognised,the larval form of the mosquito,whilst essentially aquatic in nature,breathes air. For this purpose it rises periodically to the surface of the water.Oiling the water has the effect of suffocating the larvae, and.so preventing their development into the full grown imago. I do not put forward this as anything new,as it was done in all the historical instances,but I do suggest some practical points about the process. Equal parts of paraffin and green (blast-furnace) oils were used. This proportion could be varied, according to the climatic conditions,but care had always to be taken that the oil spread and did not congregate in globules on the surface of the water.This oiling process seems,on paper, to be very simple,but there several factors one must not lose sight of else the object wished for will be defeated. The surface of the water must be clear. If weeds are floating,or reeds growing out of the water,the oil will be drawn around and up these by capillary attraction,leaving the surface clear of all oil within quite a short time. Sandy,or earthen edge also act in the same way. Wind playing upon the surface of a pool has the same effect,by driving the oil film before it,and leaving the surface clear. Obviously the remedy in these cases is

firstly,to make sure that all growth and floating weed are cleared away,and secondly,to repeat,or keep up,the supply of oil. Two methods were adopted by us in the Balkans. In the first a man was detailed as oiler for a certain area,and had to travel over this,constantly sprinkling oil on the water;in the second, a series of drip-feeds were instituted.For the sprinkling process a large sized bottle was used,with either a grooved cork,or what was equally good,pieces of twigs stuffed into the neck.The oil could be thrown from this by a circular sweeping motion,for quite considerable distances.The oiler always worked on the windward side of any extensive expanse of water. In ponds etc.,a very satisfactory method was found to be a piece of old sacking soaked in oil,and weighted with stones,thrown into the middle of it.This was found to give off oil for several days.Sacks,however,were usually at a premium,and one had to evolve implements out of what was available. After a series of experiments with drip-feeds for oil,I adopted,and used regularly a form of drip which I believe was original. In various works on Malaria,drip-feeds - tin with a hole in the bottom,and a nail through it - are mentioned.This,being very simple,was tried at first,and worked excellently - so long as you stood by and watched it. Upon your next visit the drip can and oil had vanished ! This happened so regularly that I watched on several accasions and found that the natives followed

the oil marks up the stream till they came to the can,and then annexed it for use on saddle sores on their donkeys - the native beast of burden. One had thus to circumvent this acquisition of oil shares,and still keep up the drip. I experimented with tobacco,and cigarette tins,and found that the well known tin,in which fifty cigarettes were packed by the various makers made an excellent drip-feed. It was thus prepared. A small pin-hole was made with a specially made wire nail,from within outwards,in the bottom of the tin. It is vital that this hole should have its edges everted,not inverted. Next,a stone was placed in the tin.Now,holding a finger over the hole in the bottom,the tin was filled with the oil mixture.The lid was put on. It may be observed,that in each lid is a cutter which slides backwards and forward.This ensures that the tin is not quite watertight.With finger still over the hole in the bottom, the tin was next turned upside down,and dropped into the centre of the pool.The following sketch shews a section of the tin.



In virtue of the stone inside it,the tin full of oil sank to the bottom,and rested on the lid,being kept in that position

by the stone inside. Water entered slowly by the hole at the cutter in the lid,and displaced the oil,which in turn escaped through the pin-hole in the bottom (now facing upwards). These oil globules floated to the surface of the water,and on reaching there,spread over the surface.With very little practice, these tins could be punctured so as to discharge the oil drops at any given speed. For anaverage,we aimed at one drop every thirty seconds. This was found excellent for all kinds of pools. The tins were so easily prepared,and usually to be found in abundance in the average camp.The men were told to hand to the anti-malarial squad all such tins,and the supply never ran short. Under these circumstances,it was never worth while to retrieve the tins for refilling,the 'oilman' simply carried them in a sandbag,and his bottles of oil. When he came to the pool he filled a tin,and dropped it in. This arrangement outwitted the native with regard to pools,and the next proposition was to camouflage the drip in the running streams. This was done by using the same tins,and having selected the spot where it was necessary to place one,the tin was filled - this time without the stone inside - and a hole scraped in the sand or shingle in the bed of the channel.The tin was placed in this hole,punctured end uppermost,and the sand or gravel replaced so as just to cover the exposed end of the tin,which should be left flush with the bed of the stream,and a flat stone laid over it. Wily as the Macedonian is supposed to be,and

oily as he may be,from the adoption of the 'inverted drip' he became no oilier with British Army oil in that area ! None of the tins were lost,and they could be refilled,if necessary, time after time. This system obtained the approval of D.D.M.S. and was adopted elsewhere with excellent results.

As permanent results were not being aimed at in the occupied part of the Balkans,more permanent measures than those indicated,were not adopted,but even these gave marvellous results. Areas which had been infested with mosquitoes,rapidly became free,or almost so,and the results upon the health of the troops must have been great.

While paraffin and green oil were used on the large scale,experiments were conducted to find the effect of various agents. It was found that the smallest trace of CRESOL in the water rendered animal life therein impossible. One could watch the milky cloud slowly spreading through a pool,driving all forms of life before it. Larvae,mosquito and other,beetles,frogs, andfish,all fled from it,and when further flight was impossible, perished. The price of cresol was too high to allow of its use on any grand scale,but its place as a larvicide is beyond question. CHLORIDE OF LIME was found to be efficient as a preventive, and had plenty been available,would have been more extensively used.

On several occasions I tried the effect of introducing other forms of life into pools containing larvae. I found that

a small species of fish resembling BARBEL,was very destructive to larvae,and when it was inadvisable to pollute the water on account of water supplies,troughs,etc.,this scheme worked fairly well,but they had to be constantly renewed.

It was found that the larvae of a certain species of DRAGON FLY,devoured mosquito larvae,and this was also made extensive use of.

Of all forms of animal life inimical to mosquito larvae the BOATMAN BEETLE (Notonectidae) was our chief ally. I had thousands of these transferred from pool to pool,in order to clear out the larvae.They were of great assistance so long as they remained there,but they had a nasty habit of getting home-sick,and returning whence they came.

By the above aids,it was found that water that was impossible to oil,could be kept comparatively clear of larvae. By the oiling method,unfortunately,all these other forms of life were also destroyed.One day a stream would be full of fish, frogs and larvae,and the nights hideous with the croaking of bull-frogs. After oiling,the next day the fish were floating dead on the surface,and the frogs leaping across country,seeking fresh fields and pastures new, while the nights were silent. It was found that water which had a film of oil on the surface had also diffused through it some noxious substance. If paraffin oil be shaken up in a bottle,and then allowed to settle, and the water from beneath the film syphoned off,it will be found that

no larvae can live in this fluid. Thus it may be assumed that oil,in addition to the mechanical effect of suffocation,has also some larvicidal action as well. Fish will not live in this fluid,and even frogs are most unhappy,continually rubbing their eyes,and eventually leaving the water altogether. On the strength of this,it was deemed unwise to oil wells,even when the suction pipe drew off from well below the surface,

Thus far,I have discussed prophylaxis only with regard to the larval form,but it is as essential to conduct vigorous measures against the adult mosquito.For this purpose many schemes have been tried. The old fashioned plan of a smoldering fire to windward has much to recommend it,though often the smoke in itself is very unpleasant. Burning sulphur will quickly rid a room of all mosquitoes,even when used only in small quantity. As an insecticide,this stands first of all gases,and will kill mosquitoes even when protected by folds of clothing. Chlorine gas is an effective insecticide,and for this reason it is a pity that a few gas shells had not been tried in the malarial marshes of the Struma.

Having,by the various above methods,done all possible to

i. Prevent the growth of mosquitoes,and

ii. Kill those that have developed,

there remains the next step,and that is protection from the bites of those that still exist.

Various pastes and medicaments have been recommended

for this,but these I regard as giving a false sense of security, and more dangerous through this,than protective. All efforts should be concentrated on making a building as mosquito proof as possible,and it is wonderful to what extent this can be done. Netting,of not less than eighteen meshes to the inch will keep out mosquitoes,but if the sandfly netting can be ontained,so much the better. All doors,windows,and ventilators must be covered,not forgetting the chimney,if there is one. The last can be covered with wire gauze. A single door is no use,as numerous mosquitoes can gain access with each opening of the door. Double doors,connected by cord and weight to make them self closing, and connected in such a way,that both cannot open at the same time, can easily be arranged. An important point is, that no matter how mosquito-proof a house may be,no person should sleep in it without a personal mosquito net. This is the final and most important line of defence. This must be hung in such a way that it keeps clear of the body of the sleeper,as,if it rests on hand,arm,or face,the sleeper might easily be inoculated by a bite through the net. It ought to be tucked in beneath the mattress on which the person lies,as,if it rests on the ground,it may easily leave openings for the entrance of the mosquito,or may even enclose some that have been resting on the ground beneath the bed,and it is past a joke to be shut inside a mosquito net with a hungry female mosquito.

2. MEASURES DIRECTED TOWARDS THE DESTRUCTION OF THE MALARIAL PARASITES.

As this heading is,in reality treating of measures for combatting the parasite in the human body,it really includes what is meant by the word 'treatment'.

Measures for destruction of the the parasites in the human body,fall into two categories:-

(i). The radical cure of the infected individual,the prevention of relapses,and thereby benefiting the individual, and abolishing a source of danger to others.

(ii).By administration of a drug to persons,not necessarily affected,which destroys the parasite as soon as the latter is introduced into the body,and before the incubation period can be completed.

In a comprehensive scheme of malarial prophylaxis it is most important that these should be included,as this is the complementary phase to that of mosquito destruction. It is also the more difficult phase in one sense. The mosquito is not destroyed merely to rid the world of an evil per se,but to get rid of the parasites contained in the mosquito. Strictly speaking,the compliment to this would be to destroy all patients with the Plasmodium in their blood.This,of course,is the result one wishes to avoid,so the next best is to aim at the destruction of the parasite within the human body,and free it from the invasion. Tubercle Bacilli,in a culture tube,are very

easily destroyed,Tubercle Bacilli embedded in lung tissue, present another proposition. The haemamoeba outside the human body is readily destroyed,but,circulating in the red blood cells is very difficult to get at.As a preventative,leaving the patient out of the argument,this must be attempted. Fortunately, this can be done. It has been said that no patient should die of uncomplicated Malaria. With this axiom,I quite agree.

If a patient be suffering from frequent attacks of acute Malaria,one naturally puts him under treatment for his own sake. The different forms of treatment I shall discuss later. If on the other hand,a patient has recovered from an acute attack,the tendency is to leave him alone,either without further treatment,or with some sort of half-hearted treatment. This I consider an error of the greatest magnitude. So long as that 'latent' case has a parasite in his or her blood, that person is a carrier,and a danger to the community. In England we deal rigorously with carriers of Enteric,Diphtheria,etc., and until we deal equally drastically with these malarial carriers,we shall be liable to an outbreak of Primary Malaria wherever the Anophelis exists.

Koch has said that the prompt and permanent cure of all acute cases of Malaria,and the systematic search for,and appropriate treatment of,all cases of latent Malaria in a region,will result in the extermination of the disease in that locality. This assertion,I am afraid,is too optimistic. I do

not believe that by any one part of prophylaxis will the disease be exterminated,but I do believe that by combining all known methods,that we shall go a very long way to that happy result. Koch's theory is theoretically possible,but could be carried out only in a relatively small,and thoroughly controlled community. It is,nevertheless, the prime duty of physicians to endeavour to effect 'prompt and permanent' cure of all cases that come under their care,a duty owed not only to the patient, but also to the public,and their endeavours will go far to assist in eradication of the disease.

Quinine prophylaxis. In a person who comes for the first time to a malarial country,quinine as a prophylactic,certainly is efficient.As the person continues to imbibe quinine,it seems to lose its effect,and ultimately seems to be scarcely worth counting in prophylaxis,unless the dose is gradually and steadily increased to the limit of endurance.In the Balkan army,it was pushed for all it was worth,and believed in till the supply began to run short. Of necessity,the prophylactic quinine was cut down,and in some cases had to be stopped altogether, but it was remarked at once,that the incidence of Malaria was not increased.Certainly,it must be admitted,that simultaneously with the prophylactic quinine,rigorous anti-mosquito crusades had been inaugrated,and possibly this had some effect in keeping the attack rate low.At the worst,therefore,this may be taken as an argument in favour of combination of all possible

means to attain this end.

Quinine was given to the troops ten grains per day at first,cut down later on,to ten grains twice per week,and at certain periods had to be omitted for some weeks at a time. I do not believe that this discontinuance occasionally had anything but a good effect,as it prevented a state of stability being established between the drug and the parasite. The authorities on Malaria all recommend quinine as a prophylactic, but I think to an extent beyond its merits. It has an undoubted effect of acting as a tonic, and by keeping the body fit, certainly helps it to resist attacks from without. Iron and arsenic together have this same effect,and was used with this intentionand with good results,though we did not class it as a prophylactic.The chief use of the drugs just mentioned,was to repair the damage to the blood cells made by the parasite. I do not say that harmful effects were observed from taking quinine,and where procurable,I recommend that it be taken, if for nothing more than an additional precaution. At the same time,I give warning,so that it may not give a sense of false security,and so defeat the purpose intended.

(b) Curative .

Quinine Therapeutics. Immediately a patient is suspected of suffering from Malaria,a blood film should be taken and examined. The only cases where an exception may be made,are

those which have mild recurrent attacks,and have been under treatment for some time with quinine. A negative report upon a film does not mean that the patient has not got Malaria. Many medical officers,and I suppose,medical practitioners, place too much reliance upon this as a means of diagnosis. It is interesting to give here some figures which were compiled at Salonika on this point,by Capt. Alport,in the 28th General Hospital. Out of 1,697 films examined, 119 were reported as M.T., 331 as B.T., 10 as Quartan, 103 as 'type undetermined (but present),and 1,054 'parasite not found'. At first these results were difficult to understand. The positive cases could be understood,but 1054 'not found' out of a total of 1,697 (62.1 %) was difficult to reconcile with the clinical manifestations. Ultimately,it was discovered that the climate had reacted deleteriously upon the stains,thus interfering with the results. I mention this merely to show that too much reliance should not be placed upon a 'not found' report.Again,a report that parasites were absent from the film taken at any certain time,is no guarantee whatever that they are always absent,and this must be borne in mind at all times. Having diagnosed Malaria,treatment with quinine should be undertaken at once,and kept up in a modified form until such time as the patient can be certified clear of the infection,and no longer a 'latent'case. The theory accepted in the Base hospitals

at Salonika,was to give large doses of quinine,and to keep the patient in bed for as short a time as possible - not longer than two or three days after the temperature had become normal. By getting him into the fresh air,his general health is improved and his natural powers of resistance increased. His digestive system is strengthened,the action of the excretory organs stimulated,thereby facilitating the absorption of the quinine.

Whilst I may be accused of belittling quinine as a prophylactic drug,I strongly believe in pushing it in large doses as a curative agent. Unfortunately,I was engaged most of my time 'up the line',on anti-malarial work;I had not much facility for watching closely the clinical side of the disease. The last three months of my stay,I was second in command of a Casualty Clearing Station,and benefiting by the expérience of others,I adopted the treatment as advocated here,with excellent results.

As it is absolutely essential that quinine should be introduced into the circulation at the earliest possible moment,it is obvious that if a patient cannot absorb it by oral administration,then other methods must be resorted to. It must therefore be given,first,intramuscularly;second,intravenously; or thirdly,by rectum.

(1).<u>Oral administration.</u> The average case of acute malaria should be treated by this method with quinine in solution. A

dose of 10 - 15 grains of a soluble salt in at least two ounces of water,thrice daily. It is essential that absorption be assisted by a previous dose of aperient medicine,such as Calomel Gr V,followed by Mag. Sulph.,later.This,according to Ross,should cause parasites to disappear from the blood in from 24 to 72 hours. This is the accepted cure for the malarial attacks. I shall deal later with the important after treatment,after going over the various forms of treatment for the different malarious conditions.

(2).Intramuscular administration. If,for any reason,the patient cannot assimilate quinine by oral administration,the next simplest method is that by the intramuscular route. The technique of this is simple. A syringe with a long sharp needle is required,and this must be thoroughly sterilised. It is advisable to use the Bi-hydrochloride of quinine,as being more soluble,and more readily absorbed. It should be dissolved in 5 c.c. of sterile water,or normal saline. The stab should be made deep into the gluteal muscle. Though the operation is simple,every care must be taken to avoid the nerves. There is a danger of localised abscess at the site of inoculation,as quinine has a necrotic action upon tissues. Above all,care must be taken that it is not injected subcutaneously,as this is very likely to cause sloughing of the tissues.The subcutaneous route has been strongly advocated lately by some men,in preference to

the intramuscular route,but the experience of the hospitals in the near east was such as to oppose this,and after extensive trials,the subcutaneous method was abandoned,as there were many cases of sloughing and local abscesses,much more so than resulted from the intramuscular treatment. The dose recommendéd is usually sufficient to stop the fever,but if not,may be repeated in twelve hours. In the Base hospitals,it was found advantageous to increase this dose in many cases, 20 gr.doses being frequently given intramuscularly,and repeated in eight hours,with good results. As soon as the acute attack subsides, the patient should be put upon oral administration,if this is at all possible,and kept at that for the period mentioned later.

(3). Intravenous administration. This operation requires a little more skill than the last,but gives much better,and more rapid results. This treatment is,without doubt,the soundest and best method of administring quinine in

i. Cases with mental,or nervous symptoms - drowsiness,noisiness , aphasia,twitchings,etc.;

I think it should be accepted as an axiom that every patient suffering from Malaria - clinical or otherwise - and shewing signs of a disturbance of his central nervous system, should receive an intravenous injection of quinine at the very earliest moment.

ii. Cases of severe exhaustion,anaemia,cahexia,and jaundice,

with or without a temperature.

iii.Cases of blackwater fever,bilious remittent fever,and all types of pernicious malarial infection.

The apparatus required for the intravenous administration is as follows:-

(a) Glass funnel,one inch in diameter,

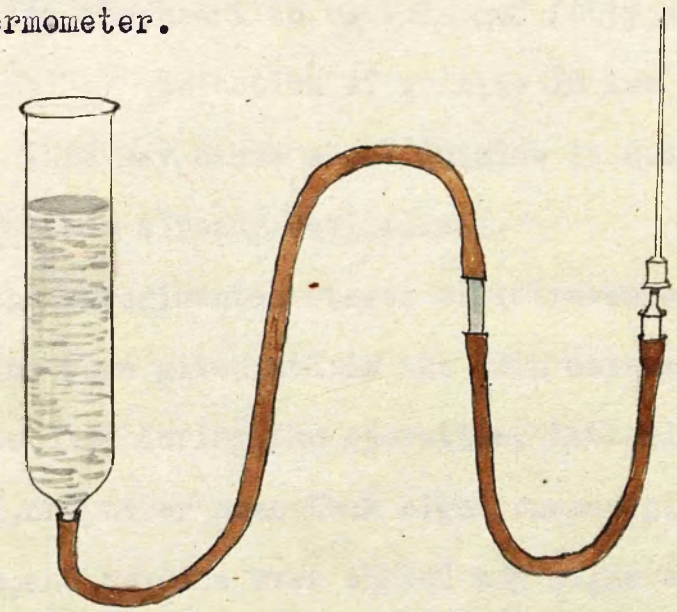
(b) Three feet of rubber tubing,with glass connection inserted.

(c) Weinstrand - or other similiar - needle.

(d) Metal connection to fit the above.

(e) Graduated measure to contain 10 fluid ounces.

(f) Thermometer.



The quinine is dissolved in Normal Saline,and injected directly into a vein,preferably in the arm. The technique is precisely the same as that for the Salvarsan treatment,and need not be detailed. By this method,Ross advocates giving one dose of fifteen grains,in five c.c's of normal saline,and to be

injected by a glass syringe. It was found that the method detailed above was more satisfactory. By it,usually twenty grains were given,in eight ounces normal saline. Rigors during, or after the operation were rare,and of no importance.

It is well to mention here the possible dangers accruing in the intravenous administration of quinine,as there is no use in shutting our eyes to possible risks.

Danger No i. An overdose of saline,causing shock,and dilatation of the right heart. It must be borne in mind that men dying from cardiac failure after Malaria,shew the walls of the heart to be thin and fatty,and the muscle atrophic.

Danger Noii. Injection of quinine in too concentrated a form. This may cause shock.Quinine is destructive to protoplasm already devitalised.

In the experimental stages of intravenous quinine,large doses of saline were given,and in the 28th General Hospital three patients died during the operation. Latterly,the amount was reduced,and never more than eight ounces,given at any one operation,and no case even shewed any signs of distress,although the dose of quinine was largely increased,and repeated at short intervals.

(4). Rectal administration. After a trial of intramuscular methods,if the patient is still not absorbing the quinine by mouth,twenty to thirty grains in eight to ten ounces of saline

may be given per rectum as an alternative. This method is of value in:-

i. Anaemic and cahectic cases,with vomiting and weak pulse.

ii.Cases with small thin peripheral veins,where it might be difficult to give it intra-venously.

iii. In Malarial patients who require plenty of fluids.

There is nothing in this method of administration requiring further discussion,the operation being simple and safe.

AFTER TREATMENT.

The routine treatment after a malarial attack is, I consider one of the essential points, both to obtain a cure for the patient,and procure safety for others,if the carrying mosquito is present. A patient suffering from malaria,may go for long enough with parasites in the blood,and yet shew no clinical symptoms whatever. This fact is of great importance,because some authorities hold that it is possible to treat Malaria by waiting till an attack supervenes,and then pumping in large doses of quinine. Unless the existence of latent Malaria is denied,this state of 'laisser faire' is dangerous. It allows toxins to be formed during this apyrexial period,which affect the heart,spleen,and nervous system. Why wait till sufficient toxins have been generated to cause a rigor,and a pyrexial attack ? I agree with Capt Alport that,as soon as the presence

of the parasite is proved,quinine should be pushed till the parasite is banished for good.

In the Balkan Army,a quinine roll was established, on which the name of every man appeared who had suffered from malaria. This was kept by each unit. Later,as a result of experience,this was replaced by a malarial card,which each man carried in his army pay book. On this card was entered,at the hospital,the dates of his attacks,and the amounts of quinine given. At any time,therefore,one could get the patient's malarial history. Each man had to undergo a course of quinine for three months.For the first fourteen days after discharge from hospital,he had ten grains every second day. From the fourteenth till the thirtieth day,he had it twice a week, and from then,forthe remaining two months,once a week. All this was entered with dates on the malarial card. These doses,I consider none too much,though they go a long way in the right direction. Only by the prolonged after treatment can the latent case - who is likely to be the dangerous carrier of the parasite - be absolutely cured.

For the guidance of medical practitioners in this country,in view of the fact of the presence of so many cases of latent Malaria returned from the army,Sir Ronald Ross recommends the after treatment as follows:-

(a). Ten grains quinine once daily.

(b). Thirty grains on each of two successive days e.g.Saturday

and Sunday each week.

(c). Thirty grains each Sunday,in three doses of ten grains each, or

(d). Thirty grains every tenth day,in three doses,as above.

If,in spite of the above,a patient has a relapse of fever,or if,even without a relapse,parasites are found in his blood,he must be treated exactly as if he had acquired a fresh attack, and go through,first,a five days course of treatment for the attack,thereafter the three months after treatment,just as though his relapse had been a fresh infection.

I have detailed above the treatment for Malaria,adapted for the different conditions. My point is,that quinine should be pushed rather more than it has been in the past,and shall mention later,when summarising,conditions likely to arise from large doses of quinine. I have not dealt particularly with Blackwater Fever,as my experience of this has not been personal enough to deal with this special condition,or to offer any original remarks upon it. I have treated the subject from the general aspect. In conclusion,I think it right that I should draw attention to one fact.According to text books,Malaria is a fever that follows definite rules,and one is inclined as a result to look for the cut and dried symptoms. In this,one is likely to be very often disappointed. It camouflages itself in many ways,and I have seen cases sent to hospital labelled as all sorts of diseases,common and rare,and found these cases

clear up only after large doses of quinine. No Medical Officer who has worked in the eastis surprised at any of the forms assumed by this disease,and the more forms one comes in contact with,the greater becomes ones belief in quinine as the only efficient drug we have at present to cope with this disease and its many phases and complications.

SUMMARY AND CONCLUSION.

In the foregoing pages,I have dealt with Malaria from the standpoint of preventive medicine. This point of view must of necessity include,in addition to the protection of the uninfected individual,the care of the infected,as only by ridding him of the parasite from his blood-stream can one hope to get rid of the various sources of the infection.

Previous to the late war,Malaria was a disease more associated with the tropics,than with our own land. The number of persons returning to this country annually,and bringing with them infected blood,was infinitesimally small,and made practically no difference in the health returns of the country as a whole. Now,however,this point has assumed some magnitude. The troops returned from the Balkans,Egypt,Palestine,Mesopotamia, and India,as well as from East Africa,have all brought with them their quota of infected blood. The only thing it would seem necessary further to make Malaria endemic in England,is the presence of the Anopheline mosquito.Let us therefore investigate this point.Midges and mosquitoes are known to exist in

England.I have personally,as recently as this last autumn,found Culicine mosquitoes in Northumberland. It must be borne in mind that it is a very fine line that divides the natural habitat of the Culex from that of the Anophelis. The chief differentiating factor in this country is the question of temperature,and as one progresses further south,this factor approaches more and more to the point where it is possible for Anophelis to exist. One is, therefore,not unduly surprised to learn that Anophelis does exist in certain areas of England. These areas are particularly in the Fen district,and in certain parts of Kent. At least three species of this mosquito have been recognised here.These are Anophelis Maculipennis,Anophelis Bifurcatus,and Anophelis Negripes.

It would thus seem that <u>all</u> the factors necessary for Malaria,DO EXIST in England. We have the infected blood,the infecting mosquito,and the fresh material,waiting to be infected. Why,then,have we not already had an epidemic of the disease ? For our escape up to the present,we are indebted to nature for the absence of the necessary temperature for the development of the sexual cycle in the body of the mosquito. Summing up these points therefore,we are left with the assumption,that,given an abnormally hot summer in these mosquito areas,it is quite possible that an outbreak of Malaria should take place,and it is with this possibility in view that these points have been raised.

Malarial Fever,under the name of 'Ague',has existed in England before,and what has happened once,can conceiveably happen

again. That,in this enlightened age,an epidemic of Malaria is possible,is a blot on the science of Preventive Medicine. The measures necessary to prevent this contingency are,after all,not so very great,and in these days of reconstruction,would involve no very heavy drain upon the finances of the Exchequer. In the Balkan campaign,of which I have given a short, and possibly imperfect,account,the protective measures did not entail a great deal of labour,and the results were certainly out of all proportion to the means adopted.

In England at present we have thousands of cases of latent Malaria. For the sake of these patients,primarily,the 'after treatment' recommended here,or something analagous to it,should be insisted upon. So long as these men are at large in this condition,they are themselves heavily handicapped,their condition is likely to progress from bad to worse,and they are at the same time potential carriers of the disease. We would not permit cases of Yellow Fever to wander at large throughout the community without taking steps to ensure their welfare,and that of their fellows. Why should we,therefore,simply because nature has placed some ban,through a matter of Latitude,on Malaria, calmly 'wait and see'what is going to happen ? This to my mind,is meeting trouble more than half way.

I have put forward a plea for increased doses of quinine. This I consider has been indicated by the results obtained in cases treated in the army hospitals in the East. Patients

treated by the recognised B.P.doses of quinine did not all react satisfactorily. Case after case relapsed again and again. Furthermore,some of these cases showed no improvement until the doses were substantially increased. Whilst frequently the smaller doses were sufficient,I repeat what I said in the last section, namely,that as soon as a patient shews any symptoms beyond what one associates with an uncomplicated attack of simple Malaria, we have an indication for immediate intravenous administration of quinine. The results of this treatment are frequently remarkable,in the way symptoms clear up,and improvement is maintained. I do not recommend that the intravenous method should be prolonged unnecessarily,for as soon as the crisis is past, oral administration usually suffices. In one of the complicated types of Malaria - Blackwater Fever - the large doses of quinine must be given with extreme precaution. As a general rule,while the excretion of quinine through the kidneys is well maintained, no untoward symptoms need be looked for. On the other hand, in the condition just named,there may be accumulation of quinine in the system,giving rise to alarming symptoms. The commonest of these we found to be quinine amblyopia,amounting in some cases to total blindness;in such cases the quinine must be stopped, and not re-started till the sight is restored. This usually takes place within a fairly short time,but the condition,while it lasts,causes a good deal of alarm to the patient,and at the

same time,anxiety to those in charge. In these pernicious types of the disease,one is placed in an awkward dilemma, and it is not always easy to decide upon a definite course to adopt, and when to with-hold,or administer the drug. If the case be a cerebral one,this point is a matter of great moment,and in that decision frequently rests the fate of the patient. In the early experiences in the treatment in the hospitals in the east,we met with cases which responded only indifferently to treatment before the heroic doses were adopted. Sometimes they showed improvement for a day or two,and then suddenly became comatose,and frequently died. At a later date,after the adoption of the full doses,one had fewer of these cases to report, and one looked back with regret upon the P.M. specimens of petechial haemorrhages over and within the cerebral tissues of these earlier cases.

Having summed up the position as regards prevention and treatment as far as England is concerned,let us now return to the Balkan area. Antimalarial measures here require to be taken up in a manner similar to those adopted in the Panama Isthmus Canal Zone. The results achieved there warrant the assumption that even greater results might be looked for here. We have a country much more civilised to deal with,already opened up in large measure by roads and railways. It has been said that the presence of an army tends to civilise a country. If this be so,then that part of the world certainly ought to

be well ahead of most parts of the world. Unfortunately,it seems to have suffered from an overdose,and requires stimulating.

In Macedonia,there are the two large valleys running east and west. That to the north - The Struma Valley - has a large,and fairly constant river running through it. The southern - Langaza Valley - has no river,the surface water appearing, disappearing to re-appear elsewhere. Organised systems of drainage must be the main line to be adopted,associated with cutting down of scrub,and clearing out of the runners all weed growth. Education of the inhabitants will be a necessary feature of the anti-malarial campaign,for so long as they accept the presence of Malaria as a fore-ordained part of their existence, so long will a large part of the work be nullified. They must be awakened out of the state of mental stupor which successive generations of tyrants has reduced them to,and taught that their condition,now at least,is very largely of their own making, and not as in the past,when they could not call their lives, let alone their souls,their own. Public propaganda towards this end should be undertaken,to enlighten them as to what Malarial infection really means,what their dangers are,and what means they should adopt to circumvent them. My own experience was, that a very little trouble,taken to explain to them what the ideal was,and what was being aimed at,had a salutory effect, even to the white-washing of insides of houses,that had never

tasted aught but occasional 'mud-washing',and further,even to the extent of 'spring cleaning' where such a thing had never been heard of before.

During my sojourn in Macedonia,quinine was practically unobtainable for civilian use. The times,of course,were somewhat abnormal,but patient enquiry elicited the fact that it never had been easily obtained. It is absolutely essential that the drug should be made more easy of access to the native. He is, even now,fully alive to the value of the drug,and realises the effect of it on the disease,but how can this help him if he cant obtain it ? Given the conditions detailed here,why should this veritable plague not be stamped out in this area,and if here, why not the rest of Greece? Then,who knows,but what this race may reclaim that lost virility,or,at least some measure of it, which,I have no doubt,the malarial parasite has robbed it of.

If this can be done in Greece,it can be done equally elsewhere,wherever the Anopheline mosquito makes the sunset hours musical with its humming - a music to many of our brave fellows,analogous to the song of death. What a scope for a League of Nations, to unite against a common foe,who recognises no laws of civilised warfare,who battens on the blood of those too weak,or ignorant,to protect themselves,and flies off to spread infection far and wide,limited only by Nature in Her wise foresight,by the laws of heat and cold !

Could the ends be attained that I have,though only feebly,hinted at,what a much brighter place would the world be to live in,and what a brighter prospect for the generations to come,with whole tracts of country opened up to them,with health assured to them by the work of the Medical Pioneer,who with experience behind him,and bright prospects before him, lays the sure foundations of Health,Wealth,and Prosperity, and who lays open the hitherto impenetrable wastes of the Earth, and in the words of Matthew Arnold,

"Cleanses to sweet air,the breath of poisonous streams."

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