exception of one small puddle under a tree which contained anopheles, I have not been able to find any larvæ for some distance around, but I hope that those more unfortunate who have pools with anopheles in them might repeat my experiment. I hope later to send you a method by which, if I may use the phrase, larvæ can by artificial means be desiccated. I am now working on this. I find that a shallow brick tank with the usual mud and leaves at the bottom, the tank being in the sun, is the best place to take the mud from. The mud when quite dry is scraped up and put into a card-board box. A small glass vase in which water has been placed is best. I take some of the dry mud and drop it on the water, this floats at first and then gradually drops to the bottom; from two to eight hours after, according to the temperature of the water, the larvæ can be seen swimming about. I find at Bareilly that tanks and certain shallow puddles contain water up to the beginning of April, during which time culex can be found. Larvæ, nymphæ and eggs are to be found in these tanks and puddles, but from April to the middle of June, or till the rains break, mosquitoes are not seen. There are no tanks or puddles, water being taken from wells. It is this period which mosquitoes have to tide over. In my experiment on eggs in April 1901 I found larvæ in the mud, though this is open to doubt, *viz.*, that they may have been introduced into the glass vessel from water taken from my tub, but from recent experiments I believe myself they were in the dry mud. My experiments, as far as I am aware, were carefully carried out, and errors guarded against; so it can be taken that larvæ of culex can survive three months' complete desiccation. This would easily tide over the period of April, May, and June in Bareilly, when water on the surface is very scarce, and I have no doubt that the period of desiccation can be considerably prolonged and the larvæ survive.

I believe this is the only method by which culex tide over periods inimical to their breeding. I have kept mosquitoes, and have tried various methods to prolong their lives; but 20 to 30 days is the longest I have been able to keep them alive, without food or water eight days. Now during the hot weather, at least in Bareilly, *viz.*, April, May and June, a mosquito is very rare, in fact I have not seen one. If they are present, what do they live on? Green vegetation is scarce, at least what one would expect a mosquito to eat. How can they then survive the three months in which water and food, I might say, are absent? I am still working at experiments to find if it is possible to keep a mosquito alive without food or water. I find if kept in the dark, they live longer than if exposed to light. It may be that mosquitoes breed in April, may have the power of hibernating, and doing without food or water; if not, I do not see how they can survive, especially in the Punjaub, where food, except animal, is more scarce than in the Upper Provinces. If they prolonged their lives on animal food, why are they not seen and felt? Eight days is the longest period I have been able to keep a mosquito alive without food or water. Under favourable conditions, from twenty to thirty days. In Bareilly I have found culex in all months except April, May and June, and it is during these months, when food for the mosquitoes, and water for eggs, larvæ, and nymphæ is absent, that the power of the larvæ of a certain age to survive dessication enables them to tide over the period during which they would become extinct.

Table giving date in which dry mud was put into water, with number of hours after which larvæ appeared, their apparent age; date on which nymphæ and mosquito appeared.

Month and date.	Hours after mud was put in water that Larvæ appeared.	Age of larvæ about	Date on which nymphæ appeared.	Date on which mosquitoes appeared.
21-8-03	Two ..	2 to 3 days	25-8-03	27-8-03
22-8-03	Four ..	2 to 3 ,,	26-8-03	28-8-03
23-8-03	Two ..	2 to 3 ,,	27-8-03	28-8-03
24-8-03	Four ..	2 to 3 ,,	28, 29-8-03	29, 30-8-03
25-8-03	Three ..	2 to 3 ,,	29, 30-8-03	30, 31-8-03
26-8-03	Five ..	2 to 3 ,,	30, 31-8-03 1-8-03	31-8-03 and 1,3-9-03
27-8-03	Six ..	1 to 2 ,,	31-8-03 and 1-9-03	1,2,3,-9-03
28-8-03	*Nil* ..	*Nil*	*Nil*	*Nil*
29-8-03	Two ..	1 to 3 ,,	1, 2-9-03	2, 3, 4-9-03
30-8-03	Three ..	2 to 3 ,,	2-9-03	2, 3, 4-9-03
31-8-03	Three ..	2 to 3 ,,	3, 5-9-03	5, 7-9-03
1-9-03	*Nil* ..	*Nil*	*Nil*	*Nil*
2-9-03	Four ..	2 to 3 ,,	4-9-03	6-9-03
3-9-03	Five ..	2 to 3 ,,	6, 7-9-03	7, 8-9-03
5-9-03	Three ..	1 to 2 ,,	12, 13-9 03	13, 14-9-03
7-9-03	Two ..	1 to 2 ,,	12, 13, 14, 16-9-03	13, 14, 15, 16-9-03
9-9-03	Two ..	1 to 2 ,,	13, 14-9-03	14, 15-9-03
11-9-03	Two ..	1 to 2 ,,	16, 20, 22-9-03	17, 22, 23-9-03
13-9-03	Larvæ	found dead	*Nil*	*Nil*
15-9-03	Two ..	1 to 2 days	18-9-03	20-9-03
17 9-03	Four ..	2 to 3 ,,	20-9-03	22-9-03
19-9-03	Two ..	2 to 3 ,,	22-9-03	24-9-03
21-9-03	*Nil* ..	1 to 2 ,,	*Nil*	*Nil*
23-9-03	Six ..	2 to 3 ,,	26-9-03	28-9-03

MALARIA: AS SEEN IN THE ANDAMANS PENAL SETTLEMENT.

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(Continued from page 448.)

THEY breed usually in stagnant pools containing vegetable débris, such as hollows in trunks of trees. This species wanders further from its breeding places than culex does, and is often found where there is no possible breeding place and where C. Fatigans disappears.

Only one variety of anopheles is known here, the A. Rossii, and that has been found only in two places. The breeding-place they affected was a series of borrow pits excavated during the building of a convict barrack. This variety was also discovered at Dundas Point. Except when these borrow pits were in existence, it was impossible to find any anopheles larvæ on Ross Island.

Another mosquito, of the sub-family Panoplites, has also been caught, but only in small numbers. Of Corethra three varieties were discovered, one of which breeds largely in the Ross drinking water tank and is the only larva to be found there.

These Corethræ appear to have no biting apparatus, and therefore can hardly be said to be carriers of infection. One variety has not hitherto been described, and appears to be a new one discovered by Mr. Lowis.

On the whole, mosquito brigades are of distinct benefit; for some unexplained reason they have not succeeded this season in Ross and Aberdeen, but in the other districts the results are encouraging. Undoubtedly the stations are much cleaner and the number of mosquitoes less, but they are far from being exterminated; they no longer flourish in the fire barrels or in the immediate vicinity of barracks, but except in very small or special areas, or where there is enthusiastic European supervision, these pests will remain and continue to carry infection.

2. *The prevention of infection by the use of nets, etc.*

At first sight this appears to be the remedy offering the best prospects. We know that a net will keep off mosquitoes, and we also know, from fifteen months' steady observation in the Female Jail, that persons sleeping under a net have only one-fourth the risk of malaria that unprotected people have, and when attacked with fever are a shorter time in hospital. The cost, too, of mosquito netting is comparatively little. Why not then introduce it?

The great drawback to netting is its interference with ventilation. Even under an ordinary mosquito net the difference in the freshness of the air inside and outside is quite marked, and this is equally the case with a larger net containing twenty or thirty people. The women in the jail complain much of the heat under the net, and it is absolutely certain that if nets are to be taken into general use as malaria guards the amount of cubic space per head must be very considerably increased, for there is practically no movement of air through the meshes of a thick net.

The question is of much importance owing to the prevalence of phthisis, and one is confronted by two precisely opposite problems. To check malaria in this way one must put up nets to exclude mosquitoes, and consequently seriously interfere with the air supply. On the other hand, to check phthisis, we must have better ventilation, more air and more superficial space. Which is the better? I think the balance is in favour of more space and more air, combined with measures to be presently discussed.

3. *The effective dosage of the whole population with quinine.*

This procedure is strongly recommended by many authorities, more especially by the Italian observers and by Koch. The theory is that the administration of one gramme of quinine daily for two successive days, and the repetition of this every week will check the occurrence of malaria by inhibiting the growth of parasites. The local opinion is against this theory, but quinine had never been given in sufficiently large doses, nor had the distribution been made on sufficiently systematic lines. Naturally, over a district comprising 130 square miles of country, and populated by men of very varying occupations, who cannot always be caught at meal or other parades, the issue of quinine regularly is a very difficult matter.

Major Anderson's experiments shewed that small doses of quinine such as 2½ to 5 grains daily had absolutely no effect on the malarial admissions of the Female Jail, but that the effects of large doses were more favourable. Longer observation has confirmed this view. Twenty grains of quinine twice weekly have halved the admissions for malaria, but the remedy is not a specific.

During the malarial outbreak last year, I directed that a further experiment should be made at Bindrabun, probably the most malarious place in the Settlement, but the results were most disappointing so far as this station goes.

One hundred and twenty men were taken and their names recorded. To the even numbers 20 grains of quinine were given on two successive days, to the odd numbers nothing. The results were as follows :—

	JUNE.		JULY.		AUGUST.	
	Quinine.	No quinine.	Quinine.	No quinine.	Quinine.	No quinine.
Admissions	42	42	31	33	21	22

Average stay in hospital. Quinine, 5·56 days. No Quinine, 5·60 days.

After August the special experiment was discontinued.

In June last an attempt was made to check the malaria by an issue of 10 grains of quinine to every convict on two successive days, repeated weekly. With the help of the executive authorities diaries were arranged, and parades organised. Compounders accompanied by Petty Officers were sent round the districts and instructed. Each man had his route and times marked out for him, so that all concerned knew what arrangements to make. In the larger stations private servants, boatmen, and others in special employ were attended to by travelling compounders, who visited the different houses and so avoided the inconvenience of such men having to attend parades or hospital. This prophylactic issue lasted from June 16th to December 1st. Some details are appended.

Altogether 496,501 doses (each of 10 grains) were issued, and about 650 lbs. of quinine expended. Over the whole period of five months more than 80 per cent. of the population were

receiving this drug, but the results were nothing like what they theoretically should have been, nor were they consistent.

Thus—

ROSS.

Average admissions July to December inclusive :
(2 years no quinine) 150
Admissions with quinine 1902 ... 236

ABERDEEN.

Average admissions July to November :
(2 years no quinine) 960
Admissions with quinine, 1902 ... 922
Some 300 increase in strength of station.

HADDO.

Average admissions, July to November :
(2 years no quinine) 818
Admissions with quinine, 1902 877
Some increase in strength of station.

SOUTHERN DISTRICT.

Average admissions, July to November :
(3 years no quinine) 1,234
Admissions with quinine, 1902 1,372
Considerable increase in strength in Southern District.

WIMBERLEY GANJ.

Average fever admissions, July to November :
(2 years no quinine) 1,671
Admissions with quinine, 1902 1,759
Considerable increase in strength of station, so that fever admission rate per mille of strength is lower.

FEMALE JAIL.

Total fever admissions 15 months—
(*a*) receiving quinine 362
Average stay in hospital 5·5 days.
(*b*) not receiving quinine 695
Average stay in hospital 7·35 days.
Strength of each class nearly the same.

At first sight it would appear that the issue of quinine has done little or no good, or at most that the results have been inconclusive. But 1902 was a particularly unhealthy year, and it may fairly be assumed that but for the quinine the malarial admissions would have been even higher than they were. Thus in the two unhealthy districts (Southern District and Wimberley Ganj) the fever admissions in the pre-quinine period of 1902 were very much higher than in previous years, whilst after quinine was given, the figures assimilate very closely.

SOUTHERN DISTRICT.

No quinine.

Three years average malarial admisssions January to June inclusive	1,983	Average, July to November ...	1,234
Malarial admissions, same period 1902, no quinine ..	2,938	Same period 1902, with quinine ...	1,374
Increase in admissions in 1902	955		142

WIMBERLEY GANJ.

2 years average malarial admissions, January to June inclusive ...	2,149	Average, July to November ...	1,671
Malarial admissions, same period 1902, no quinine ...	2,668	Same period 1902, with quinine ...	1,739
Increase in admissions in 1902	519		88

Thus quinine seems to have brought the very unhealthy year back to the level of the previous ones, although the population has increased.

It is possible that the prevalent type of malarial parasite is largely responsible for the inefficacy of quinine as a prophylactic. One of the commonest parasites is the malignant tertian, and this, as is well known, is particularly resistant to quinine.

This fact, with the known frequency of malignant crescents existing without fever or symptoms, has an important bearing on malarial prophylaxis.

4. *The keeping of the whole population "fit" by guarding them from unnecessary exposure and cold.*

This suggestion has been already discussed above under the relapse theory, and little more requires to be said.

It is obvious that the better general health our men are in, the less likely they will be to succumb to malaria or other disease. But here the great difficulty is the interference with discipline and with the work of the administration.

If labour in swamps, forests and brickfields is prohibited, if work is to stop at every shower of rain, then I do not doubt that the sickness will decrease, but it does not appear advisable to recommend any such procedure or to attempt to interfere with necessary forms of convict labour in the Settlement.

Apart from any such steps we may improve the cooking and food supply, we may introduce drying rooms, issue extra clothes and so ensure that the convict shall have dry things to sleep in. Sanitation, air space, and so on can be attended to, and an occasional extra ration may be issued when the labour is excessively trying or hard.

With this object in view it is proposed to utilise the Aberdeen drying room for one particular section of convicts during the coming wet season, to make such arrangements as will ensure dry clothes to them and possibly to make special arrangements about their food. Contrasting with these there will be another section doing the same work, living in the next barrack, but not receiving the special advantage of dry clothes. The results will be of great interest and will be carefully noted.

I have detailed above the four principal methods in which we may combat malaria; it is now necessary to discuss their relative merits and practicability.

It has been pointed out that, as far as actual admissions go, the mosquito net undoubtedly has the best effect, especially in the case of

women living under jail conditions, not doing hard out-door labour or exposed to rain and storm. But the ventilation difficulty is insuperable unless a very much larger amount of cubic space is provided—a larger amount than one could justly recommend.

We are left, then, with mosquito brigades, prophylactic quinine and general sanitation, and it is to these that we must look as means of checking malaria. I have endeavoured to shew that the two former have already had some good effect. It is not unreasonable to hope that as experience is gained in the working of the mosquite brigades, better results may be hoped for. The prophylactic issue did do good, and, I think, not only by diminishing the admissions, but over the whole Settlement by lessening the periods of detention in hospital. This opinion is supported by the various medical officers in charge of the Settlement hospitals, especially in the female jail (q. v.).

For general sanitation we must rely largely on the executive officers in immediate charge of the convicts. It is to their interest to have a low sick rate, for the fewer men they have in hospital the more easily can remunerative work be undertaken.

In conclusion I advocate the following measures as the most suitable for the checking of malaria:

1. The retention and, when necessary, expansion of the existing mosquito brigades. The expert trained part of each gang should be permanent and not available for other work. The coolies, drain makers, &c., may of course be taken on and off as required, but the Petty Officer of the gang who knows what a mosquito larva is like, who can recognise culex eggs and knows the usual hiding and breeding places of the insects should be a fixture.

2. The general administration of quinine throughout the Settlement in prophylactic doses.

3. The establishment in the outlying and unhealthy stations of branch dispensaries supplied with quinine and simple remedies. This plan was tried last year with much success, both in the treatment of malaria and also of dysentery. It at times enabled us to get hold of patients earlier than we otherwise should have done and to save invaluable time in treatment.

So far we are hampered by want of an adequate Medical and Compounder staff, but it is hoped that more assistance will soon be available.

4. The provision of drying rooms or drying frames at every station, and as a corollary the issue of extra clothing.

I do not regard the drying room as a panacea for all evils, but I am sure that giving a man dry clothes to sleep in and a good, hot, well-cooked meal, when he comes home from work, will enable him much more successfully to fight against malaria and other climatic diseases.

5. The restriction of such unhealthy forms of labour as firewood cutting, swamp work, &c., to the narrowest limits, and the granting to men so employed of a small extra food ration. I regard the proposed substitution of coal for firewood as a most valuable idea, and one which cannot but have a good effect on the general health.

6. The continual stimulation of local public interest in the health of the convicts. One would like to see competition between stations as to which should have the lowest sick and death-rates and whose malarial admissions should be fewest.

I should like to add a few remarks on the clinical characters of the malaria as locally observed, and on the various methods of treatment in use.

Owing to the nomenclature adopted by the Royal College of Physicians, we are obliged to define our malaria cases as remittent or intermittent fever. This is a most unsatisfactory classification; many cases are remittent (in the sense that the temperature does not touch normal) for the first two or three days and then assume an intermittent type for a longer period. Such a case may recover and be returned under either heading according to the ideas of the Medical Officer in charge of the case. On the other hand, such a case may die after a stay of some weeks in hospital, during the latter part of which stay the temperature may have been normal, intermittent or even subnormal at times. Yet that case may reasonably be shown as remittent fever by one man and as intermittent fever by another.

In the Port Blair returns "remittent fever" may be taken to mean a severe type of malarial fever, and all cases dying from remittent fever are considered as malarial.

These 'remittent' cases occur in all parts of the Settlement, but especially in the less cleared areas like the Wimberley Ganj and Viper Sub-Division. 148 cases with 48 deaths were thus returned in 1902.

Many of the cases are rapidly fatal, the patients often being brought to hospital in a dying condition. Three or four days is a very common period for the patient to survive, and delirium and coma are frequent before death. Hyperpyrexia is not common, though in one fatal case a temperature of 110° was noted, and in another non-fatal case one of 107°.

The men attacked are often old malarial subjects who have many previous admissions for the disease; one patient had 24 previous admissions recorded, others had 15, 12, 10, and so on.

Malarial parasites are occasionally but not often found. As is well known in these pernicious cases, parasites are often absent from the peripheral circulation.

On *post-mortem* examination, the outstanding features are the general congestion of the organs, especially of the brain and its membranes, the

abundance of cerebro-spinal fluid, and the enlargement of the liver and spleen. The latter in 29 examinations averaged 22 ounces in weight, whilst the liver was frequently well over 70 ounces.

These cases coincide very closely with those described by Pewintzky of St. Petersburg in his essay on Pernicious Swamp Fever. (*Journal of Tropical Medicine*, July 1902).

The possibility of some of these cases being cerebro-spinal fever was considered, but no definite evidence of this disease was obtained, either clinically or microscopically.

Some of these remittent cases yield readily to treatment, but others are most intractable. Hypodermic injections of quinine are freely given, in some cases with much benefit, only rarely with none. Large doses of quinine by the mouth and by the rectum have also been tried. Methylene blue acts well in some obstinate cases. Latterly we have been giving "mass doses" of 30 grains of quinine by the mouth or hypodermically, and in most cases with good effect. Often the temperature falls at once and remains down. In no case have we noticed ill-effects from these large doses, nor is hæmaglobinuria known.

An attempt is now made to examine microscopically the blood of every patient who comes to hospital complaining of fever, and in this way the blood of 4,304 patients has been searched. In many cases two, three or even more examinations were made.

Parasites were found in 2,338 cases. The chief varieties noted are:—

Intracellular hyaline, 776 cases; hyaline ring form (malignant tertian), 438 cases; pigmented intracellular, 704 cases; pigmented extracellular, 273 cases; crescents, 123 cases; segmenting forms, 20 cases; and flagellæ, 2 cases.

More attention was paid to the presence or absence of parasites than to the particular variety, but it is interesting to note that quartan parasites were far from rare, and would often resist quinine for some days.

It has been stated (Report of Royal Society's Malaria Commission) that native children frequently harbour parasites without symptoms or rise of temperature. This I can partly confirm. Many children in whose blood we found parasites said they were perfectly well, but on investigation were found to be suffering from fever or from enlarged spleens.

For example, *all* the children in the Female Jail and attending the Aberdeen School were examined:

Number of children, 158; parasites found in 58 cases; of these on examination, 40 had fever or enlarged spleen; whilst 18 had no fever.

Varieties of parasites:—

Intracellular hyaline, 22 cases; intracellular pigmented, 23 cases; extracellular, 10 cases, and crescents, 2 cases.

Again at Haddo, 68 healthy-looking persons (including Andamanese adults and children, school children, &c.), were examined. Parasites were found in 11 cases, but all of these on examination were found to be suffering from slight fever.

With regard to the diagnosis of malaria by means of differential blood counts, our results do not altogether agree with those of Rogers. Over 63 counts, and never of less than 500 leucocytes, the average is:

Large mononuclears	14·00
Lymphocytes	25·00
Neutrophiles	59 00
Eosinophiles	5·00
Others	2·00

Rogers claims 15 per cent. of large mononuclears as a diagnostic sign in malaria, but we do not always get such a high percentage.

We have taken specimens in which the crescents were double the large mononuclears, and yet the percentage of the latter was only 14 per cent.

For instance:

Large mononuclears	14 per cent.
Lymphocytes	21·8
Neutrophiles	60·0
Eosinophiles	2·8
Others	1·4
	100·00

Actual count, 501; crescents found, 137; red blood corpuscles, 4,026,000 per c. millimetre; and white blood corpuscles 6,000 per c. millimetre.

On the other hand, in a case of dysentery not complaining of fever, the following count was made:

Large mononuclears	16·3	
Polynuclears	46·9	Total count, 509.
Lymphocytes	34·2	
Eosinophiles	1·0	Crescents present, 58.
Others	1·6	

Here the malarial factor of large mononuclears was present, even though the usual dysenteric increase of lymphocytes was marked.

Altogether, 265 differential blood counts have been made, and many results of considerable clinical interest elucidated.

The convicts that I have trained for microscopical work have been of the greatest use. These men are now well conversant with the different forms of parasites, can make and stain their own preparations, and in some cases can perform differential blood counts.

"LIVER CHILL," AS A FACTOR OF DISEASE IN THE TROPICS.

By A. E. GRANT,
MAJOR, I.M.S.

(*Continued from p.* 413, *November* 1903).

TAKE the case of a man whose night suit has shrunk to most unsuitable proportions owing, most probably, to the handiwork of the unspeakable *dhobi*. He goes to bed, let us say, comparatively cool and comfortable, but fails to get sound sleep. During the night he tosses, tumbles and becomes bathed in sweat. At dawn a light breeze springs up and lulls him into