The malarial fevers of British Malaya / by Hamilton Wright.

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Publication/Creation

Singapore : Kelly & Walsh, printers, 1901.

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STUDIES

FROM

INSTITUTE FOR MEDICAL RESEARCH,

FEDERATED MALAY STATES.

No. 1. **[Vol. 1.]**

THE

MALARIAL FEVERS

OF

BRITISH MALAYA.

BY

HAMILTON WRIGHT, M.D. (McGILL),

Director of The Institute for Medical Research, Federated Malay States.

Singapore:

KELLY & WALSH, LIMITED, PRINTERS,

32, Raffles Place.

August, 1901.

Price Three Shillings.

ERRATA.

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NOTE.—Where "signs and history of fever" appear in accompanying tables it is to be understood that a careful inquiry was made of parents and teachers, that the spleen was examined in each case, and that where there was reason to suspect active fever a blood examination was made.

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THE MALARIAL FEVERS OF BRITISH MALAYA.

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HAMILTON WRIGHT, M.D. (McGILL),

Director, Institute for Medical Research, Federated Malay States.

The following observations do not represent an exhaustive study of the Malarial fevers of the British portion of the Malay Peninsula. They are rather a first step in several directions which I hope will stimulate those concerned to a more scientific study of the subject than has been the rule in the past. I hope also that it will reveal to European students of Malaria the value of this as a field for research.

There is little or nothing in the literature to indicate the extent to which Malaria prevails in the Malay Peninsula, the types of parasites to be found, and their association with Anopheles.

The study of the statistics compiled here and paragraphs of annual reports dealing with Malaria do not much enlighten one. No two classifications are filled up exactly alike and all are of the days before the various types of parasites were known. The type or types of parasites is not mentioned with any degree of certainty, and it is therefore thought by many in Europe that, like the West Coast of Africa, the Malay Peninsula is rife with the Malignant Tertian only.

I have been over most of British Malaya and my observations tend to show that the same types of Malaria prevail in all parts of the Peninsula, that certain types of the parasites are readily observable in all their early stages, and others in all their stages of development, providing no quinine has been given.

It is time, therefore, that the old classification based on temperature variation, excellent in its time, be done away with by this Medical Service with a Government behind it generous in the matter of microscopes.

It is no argument to say that a rigorous classification based on the parasitic type is too ideal. The Medical Service itself must raise the ideal of classification. Error will not be wholly excluded, but it will be better to have it under a high than a low standard.

The study I have made has been over almost the whole of British Malaya, *i.e.*, the States of the Malay Federation: Perak, Selangor, Negri Sembilan and Pahang; and the Colony, *i.e.*, Singapore, Penang, Dindings, Province Wellesley and Malacca. Johore is included in an indirect way.

For convenience sake observations made in different parts of the Peninsula are arranged under the head of Observations 1, 2, 3, etc., and I will so refer to them when necessary. They were conducted with several objects in view:

1st. To determine the Types of Parasites.
2nd. The Incidence and Degree to which each kind of fever prevails.
3rd. The Age of those chiefly affected.
4th. The Species of Anopheles present, and the Relation of the Genus to the Propagation of Fever.
5th. To determine the Preventative Measures best suited for this particular locality.

Types of Parasites and their Relation to the Temperature Curve.

In the Malay Peninsula are to be found four and perhaps five of the known parasites of human Malaria.

Out of 251 cases of fever personally studied by me—

93 were Malignant Tertian
78 ,, Benign ,,
56 ,, Quartan
22 ,, Pigmented Quotidian.
2 ,, Unpigmented ,,

This is probably a fair index of the proportions in which, throughout British Malaya, the different Malarial fevers prevail.

Malignant Tertian.

The most common parasite, so far as my own experience goes, is the Malignant Tertian. I have found it in almost all Malarial foci. In certain foci no other forms exist. I have found it at all times of the year, but there is some evidence to show that it becomes more common in the summer-autumn months. A longer observation than mine will be necessary to fully determine this point.

It is rare to see a case of single infection by the Malignant Tertian parasite. Cases generally show a multiple infection. I have records showing two distinct generations of immature parasites present in the peripheral blood, when by the chart and condition of the patient one knew that a mature group had or was in the act of sporulating in the internal organs. Many patients enter the hospital almost comatose; picked up by the police and sent in.

The paroxysms of fever are not usually severe in natives; one rarely gets the history of an annoying onset from them. Case 5 very well illustrates this type of fever. This patient was certainly infected by three distinct groups of parasites all of which disappeared from the peripheral blood on the proper exhibition of quinine. Case 14 will give an idea of how far a patient may be infected before he seeks hospital treatment. The result is generally death within 24 hours of admission.

The native mind is not yet pitched to absolute faith in European Medicine and the coolie class of Chinese especially first test their own drugs before seeking hospital aid.

Pernicious fever such as that described by Dr. CONNOLLY (Case 99) is rare. I have inquired diligently and have heard of only a few cases. I have not myself seen such a case; or a case of Blackwater Fever.

Amongst Europeans the prodromata observed in other parts of the world are common, and severe vomiting, diarrhœa and even delirium are the usual accompaniments of a well marked cold, hot and sweating stage.

The Temperature Curve. In a case of single infection it does not differ from that usually seen in Italy, America and the West Coast. Careful blood examination shows that the rigor is related to the maturation of a group of parasites.

The Live Malignant Tertian Parasite.

The earliest form I have seen in the endo-corpuscular stage is the small, extremely active, unpigmented amœbulæ which almost immediately after the blood is drawn throws itself into a ringlet or discoid and remains while in these forms absolutely motionless. These are first observable about three hours after the height of the paroxysm. In a rich specimen such as Case No. 5, it is not unusual to find an average of six infected cells in ten fields. (Zeiss Oc. 4, Ap. Ob. 2 m.m.) The small active forms are common, but quickly form ringlets and discoids soon after the blood is drawn. Occasionally a ringlet opens out into a slender, active, pseudopodic body. The signet ring appearance is observable a few hours after the earliest forms are noticed in the blood.

At the end of from 22 to 48 hours a few pigment granules appear in the peripheral layers, first in the discoids, later in the ringlets.

The pigment grains, at first extremely minute, oscillate markedly. I have never seen them in the earliest forms absolutely quiescent as they appear to be in cases I have distinguished as Pigmented Quotidian. When four or five well defined granules appear they dance in a lively manner. In a warm chamber I have known this to continue for several hours with only slight movement in the parasite itself, or enlargement of it. At the end of 48 or 50 hours the parasite has grown to about a quarter or third the size of its host. The pigment developes from a fine dust into granules and rods of a dark reddish colour. It is never in great amount or diffused through the parasite.

When this point is reached the parasite tends to disappear from the peripheral blood. In the majority of cases as soon as twelve or fourteen rods and granules have been developed they begin to mass in the centre or at one point of the periphery of the parasite, and their movement grows sluggish, with occasional slight bursts of activity.

I have often found, as noted by other observers, certain of the red hosts shrivelled, and brassy looking with a well marked ringlet embedded in each. On the other hand, I have seen cases in which, so long as I was able to follow the growth of the parasite in the peripheral blood, there was absolutely no change in the size, shape or colour of the infected red cells. Such cases are generally first infections seen early.

I have not yet observed sporulation in the peripheral blood, but on puncturing the spleen shortly after the beginning of a paroxysm I have seen it as described by the Italian observers.

Of the Crescentic series I have in all cases of Malignant Tertian observed the typical crescents and the cigar shaped, oval and spherical bodies of the crescent series. The true crescents I find when the blood is first drawn, while the globular and fusiform bodies are not common till some time after. It is not my experience that the concentrated pigment of the true crescent is absolutely quiescent. With a Zeiss 20 mm. Objective and No. 6. Comp. Oc. I have always been able to detect a movement, very sluggish it is true, in all but the most concentrated masses of crescent pigment. The whole crescent also slowly changes its form. Observation carried over many hours in a Pfeiffer's warm chamber has often exposed the development of globular, oval and cigar shaped bodies from true crescents.

In perfectly fresh specimens it has not been my experience to find endo-corpuscular fusiform, and oval bodies common as compared to true crescents.

The formation of flagellated bodies from crescents I find to occur with greater ease if the slide is moistened by one's breath as suggested by Manson.

My observations appear to support those of Manneberg in regard to the genesis of the crescent—the syzygium—from a corpuscle doubly infected by parasites—syzygies.

In Case 5 at 11.30 a.m., June 10th, I found an enormous number of doubly infected cells. The parasites (syzygies) were almost mature and in most cases apparently flattened out on one side of their hosts.

In the stained specimens the syzygies appear to be in the act of conjugation. In the unstained specimens I could not make out with any degree of sureness the line of separation between the different syzygies. But in stained specimens each pair distinctly exhibits a line of demarcation, nuclei and nucleoli. Coincident with this were a few immature crescents in the blood; no mature crescents till quite a week later.

Benign Tertian.

The next most frequent is the Benign Tertian. I have not yet become acquainted with a locality where this type of parasite is the only one present. It is generally found along with the Malignant Tertian and Quartan. Its parasite differs in no way from that seen in other Malarious regions.

In the clinical manifestations so far as the Orientals are concerned one does not so often have to record the annoying prodromata that occur in Europeans. The patients generally give a fairly clear account of fever occurring, at first every third day but gradually leading to daily attacks. Only then in the great majority of the coolie class is hospital admittance claimed. I have rarely seen in hospital a chart that indicates a single group of parasites in the blood. Chart and blood generally indicate a double infection (see Case 1) often associated with a single infection of either the Malignant Tertian or Quartan. In one case I observed two groups of the Benign Tertian associated with a single group of the Pigmented Quotidian ; the maturation and sporulation of both parasites almost coincided.

Enlargement of the spleen is common. Anæmic symptoms are not rare.

One dose of quinine properly given and the patient kept at rest generally destroys so many parasites that a rise of temperature does not again occur for some days. But three or four doses given on successive days clears the blood of parasites. Case 1 is a fair example of the Benign Tertian as it exists here.

Europeans generally manifest the fact of their infection more than natives. But in this type of fever the exhausting, diarrhœa and vomiting is not so often seen as in the Malignant Tertian. Delirium is rare in an uncomplicated case.

The Live Benign Tertian Parasite.

An actively amœboid colourless body of extremely small size apparently lying first upon but soon penetrating within the peripheral layers of an erythrocyte is the first observable stage of this type of parasite. I have but seldom observed it in the act of invasion. In fact I find that only rarely can one detect the organisms till about five hours after the rigor. The organism at this stage may meet the eye as a blunt pointed star, as a disc or as an irregular body with one or two shorter or longer processes. The change in shape is rapid. Nothing suggestive of a nucleus can be seen.

It is difficult to say just how much these earliest forms increase in size before pigment can be detected in them. Perhaps after they have grown from a fifth to a quarter the size of their hosts the first grains of fine, dark-brown or black pigment appear. The earliest appearance of pigment that I have observed was nine hours after the crisis. It was present in about half of the many plasmodia present. Twelve to fourteen hours from the attack,

however, almost all observable forms are finely pigmented. The pigment appears as minute granules and occasionally rods, almost black in colour. They are most numerous and swarm most rapidly in the outer portions of the plasmodia.

During the second twelve hours after the attack the parasites continue to grow, but this is only noticeable by comparing specimens taken at twelve and twenty-four hours.

At twelve hours the parasites fill about one-third of their red hosts, at twenty-four hours a little more than one-half. The containing erythrocytes have in the meantime enlarged and grown pale.

By forty hours the parasites have grown considerably and fill about four-fifths of their hypertrophied red hosts. The pseudopods are sluggish, but the pigment now in great quantity swarms rapidly. The parasite at this stage is often shaped like an irregular trefoil or quarterfoil; each leaf containing a mass of fine granules and rods actively swarming; the central and connecting parts may be quite clear. The red hosts have greatly enlarged and lost colour.

In cases where no quinine has been given for a week or ten days, I have drawn specimens of peripheral blood five or six hours before the attack and found them literally crowded with almost mature parasites. The number that one may sometimes observe is far in excess of the number of hyaline forms to be seen under the most favourable circumstances.

In many of the almost mature forms the pigment is quiescent. These forms are large, round and almost fill the distended colourless red cell. Segmentation and sporulation can always be observed in the peripheral blood in rich specimens. So far I have rarely seen any method of spore formation other than the first type of Golgi, where the pigment masses itself centrally and the parasite disintegrates into numerous (sixteen to nineteen or twenty) rounded spores. These immediately become more refractile than was the mother protoplasm. Once or twice only have I seen Golgi's sunflower type of sporulation.

In all cases after the parasite has reached middle age, extra-corpuscular forms are to be seen shortly after the blood is drawn. If the specimens are vaselined these forms appear late, if not so protected, early. In many the swarming of the pigment is much more rapid than in any endo-corpuscular forms. But this tends to cease, so far as my observation goes, shortly after the escaped parasite breaks up.

The flagellated bodies I have been able to demonstrate quite readily by following Manson's advice to breath on the cover slip before taking up the blood. The shortest time that elapsed from the drawing of the blood to their detection in the specimen was sixteen-and-a-half minutes.

I have never seen early spore formation in Tertian Fever, where only eight or ten spores occur.

In several instances of this and the Quartan fever I have observed what looked like small, free, pigmented bodies about a third the size of a red cell. The pigment swarms, but the organism itself is quiescent. At first I took them for parts of broken up large extra-corpuscular forms. But on closer observation I found them interred in absolutely colourless bodies (phantoms) the size and shape of a normal red cell. These bodies (phantom cells) are so nearly the consistency of the plasma that they readily escape observation.

Quartan Fever.

The Benign Quartan ranks next in frequency. I have found it in more than half the Malarious localities I have visited and, like the Tertians, it is frequently seen in hospital.

Single groups of parasites are not so rare in the blood, as in the Malignant and Benign Tertian fevers. Fifty per cent. of my cases were single infections and the group of parasites maturated in from seventy to seventy-five hours.

Several times, as illustrated by Case 7, I have seen what was originally a single group apparently break up into several distinct groups either by anticipation or postponement of maturation. It is possible, of course, that the multiple infection occurred before the patient was admitted to hospital and that afterwards the parasites of the second and third groups so far developed as to cause a distinct rise of temperature. But this case was carefully and often observed from the time of admission and there was no gradual but only a sudden appearance of group 3.

This case well illustrates the benign character of the fever as seen here. At no time while he was under observation did he appear distressed. Even when his temperature was highest he sat up and talked cheerfully. He constantly asked to be discharged and finally absconded shortly after all parasites had disappeared from his blood on the exhibition of quinine. Case 9 illustrates a single infection by the parasite of this type of fever.

This type of fever is pretty evenly distributed over the whole Peninsula, I have never had difficulty in detecting its parasite from its earliest to its latest phase in the peripheral blood.

The Live Quartan Parasite.

The youngest forms of this parasite are indistinguishable from the Benign Tertian in the same stage of development. It is actively amœboid until pigmentation begins. I have found it easier to detect in its epi-corpuscular and earliest endo-corpuscular stage than the Benign Tertian. It is also more refractive than the latter. In about twelve hours a grain or two of coarse pigment can be made out in the peripheral layers. It has grown now to about a sixth the size of its host, movement is sluggish, and its outline has grown sharper. Growth continues along these lines till about eight or ten hours before the paroxysm when segmentary alterations appear. The red host can just be made out as a pale rim of hæmoglobin. In no stage of development does the red cell enlarge or change in colour.

A radial arrangement of the coarse rods and granules of pigment is the first stage in sporulation and is always readily observable in the peripheral blood. The pigment gradually moves towards the centre of the parasite, becomes massed into an irregular block and loses all motion. Even when the pigment is radial the striæ of division are noticeable, but cannot be seen to wholly reach from the centre to the periphery of the organism. As soon as the pigment is massed, however, the striæ develope in full length and the refractive eight or twelve spores begin to stand out plainly. Segmentation soon follows.

Extra-corpuscular bodies appear rapidly in unprotected specimens. For a short time after they have burst from their hosts the pigment is quiescent. But in many instances it soon dances and swarms actively. The body swells, and rarely breaks up into one or two small and one large segment.

Those of the extra-cellular bodies that develope flagellæ do not appear to be so numerous as the corresponding Benign Tertian forms. The appearances of the flagella are not distinguishable from those of the Benign Tertian bodies.

In many cases multiple infection has been observed. In other cases I have seen an original group of parasites break up into two and even three, the second and third group lagging behind the original group from which they appear to be derived.

Case 7 illustrates this well. He had had no quinine up to the time of observation, June 6th. At 3 p.m. of this day he exhibited a group of parasites all mature and many of it showing signs of segmentation. A paroxysm occurred at 8 p.m. A second group was also observed at 3 p.m. about half matured. At 12 midnight of the 7th, a paroxysm occurred. The spores of group 1 gave rise to a paroxysm 72 hours later, on the 9th. Spores of the 2nd group to a paroxysm about 70 hours later, between 8 and 12 p.m. of the 10th. On the 11th, at 12 midnight, a paroxysm was interpolated as though members of group 1 had prematurely sporulated. At 12 p.m. of the 12th, the regular members of this group must have matured. Group 2 again sporulated at 12 midnight on the 10th. And this arrangement continued till the 17th, when another paroxysm was interpolated at 10 p.m.; and again another at 2 a.m. From the slight rise that took place at 4 p.m. on the 17th, it would appear that only a part of the premature half of the original group 1 had sporulated and that parts of it had later on sporulated at 10 p.m. on the 17th and 2 a.m. on the 18th. This breaking up of an original group seems to have gone on and led to the peculiar chart tracing.

Pigmented Quotidian.

I have seen 22 cases of the Pigmented Quotidian. The most severe gastric, cerebral and bowel symptoms are associated with this form. Cases 15 and 20 well illustrate this and the associated temperature variation. It is not a common type of fever here but I think it is distinct.

After watching Case 20 for several days and finding only young and almost unpigmented parasitic forms plentiful in the peripheral blood, I had the spleen punctured and obtained clinching evidence that I was dealing with a single group of parasites that in part pigment and undergo sporulation in the spleen.

The live Pigmented Quotidian Parasite.

I have not seen this free or epi-corpuscular. But it is to be seen in the earliest stage of its endo-corpuscular existence; it is small and very active. The outline at this stage of growth is really indistinct and the parasite may escape observation. The parasite comes to rest in this climate from twenty minutes to an hour after its abstraction, taking the form of a distinct ringlet with a centre not greatly different from the surrounding hæmaglobin of the red host. This ringlet is often seen to break again into an active amœboid plasmodium. Fine reddish grains of quiescent melamin develope in the periphery of the organism about ten hours after the rigor. Its movement is slight and is scarcely to be observed in the majority of instances.

Spore formation is preceded by a concentration of the pigment generally centrally but not rarely peripherally. The plasmodia is now about a third the size of its red host, lines of cleavage appear and it breaks up into nine or ten small spores. I have never seen this parasite in the peripheral blood after the first few grains of pigment appeared. But in Case 20 I was able to follow it out by puncturing the spleen.

Following the breaking up of the parasite the mass of pigment disintegrates into several smaller masses or isolated fine grains. I find, as other observers have, that many of the infected cells shrink and become coppery in colour.

In Case 20, whose spleen was punctured as his temperature began to rise, I found a large number of sporulating bodies. Crescentic bodies I have never failed to find in Pigmented Quotidian cases.

Unpigmented Quotidian.

The unpigmented quotidian of Grassi and Felletti I have not observed unless Case 10 be such an one. By reference to this case it will be seen that I found no evidence of Malarial Fever in the peripheral blood except a few pigment grains free or endo-leucocytic. But on puncturing the spleen pigmented and sporulating parasites were observed. Crescents were not at any time seen, and there was nothing in the epiphenomena to point to malignancy.

It may be a Pigmented Quotidian. But I am inclined to think that it is rather a new type of Benign Quotidian that will explain several cases I have seen here of daily rises of temperature and nothing but pigment to be seen in the peripheral blood.

Incidence and Extent to which Malarial Fever prevails.

Although cases of Malaria crop up in all parts of the Peninsula under consideration, it may be safely stated that the European quarters of the large centres of population are practically free in spite of the presence of myriads of Anopheles.

It is rare indeed to find a European with fever contracted within the European quarters of the larger centres of population. Those who present themselves with fever generally give a history of having been at outstation or jungle work in some Malarial focus. A few days after the return fever developes. Kwala Lumpor (Map C. 4), Taiping (Map B. 3) and Seremban (Map D. 5) are well drained, clean and practically feverless centres. Anopheles abound but they are not infected. I have examined many Anopheles from the European part of Kwala Lumpor and found not one infected.

It is really remarkable, too, that in the Kwala Lumpor Gaol where there are never less than 300 prisoners and where Anopheles superpictus abound, Malaria is almost unknown. Anopheles are plentiful but rarely infected.

The Europeans of Singapore (Map E. 6, Obs. No. 13), Penang (Map B. 2, Obs. No. 9) and Malacca (Map D. 5, Obs. No. 8) rarely, if ever, contract fever within the European quarters of their towns. Nearly every case will give a history of a recent shooting or official trip into the jungle, and generally a visit to some now known Malarial focus.

A certain number of them whose devotion to obsolete Malarial theories is remarkable in contrast to their incapacity to accept the mosquito theory get fever regularly after drinking clear water running over granite. It is their chief delight to insist that so and only so could they have contracted fever. When such cases are investigated and proved by blood examination to be Malarial it is generally found that they have recently been in notorious Malarial foci where Anopheles abound. If such cases prove not to be Malarial it is usually found that the sufferers are comforting themselves with a name that cloaks some more pernicious disease than Malarial fever.

There is a tendency, too, on the part of many Europeans to make the clinical thermometer a fetish. An afternoon passed without the temperature being taken would be a deadly neglect of the little god of glass and mercury. The blood of such chronic sufferers from Malaria shows no indication of the parasite. Reckless dosage by quinine has no effect. It is impossible to convince them that they are Malaria free and that nine out of ten of the healthiest of individuals will show at almost any time during a hard day's work a similar degree or so of temperature above normal. In the minds of such the normal physiological rise following exertion is regarded as pathological.

But one meets with an entirely different picture when one turns to the native populations.

The vast majority of the fever stricken are Tamils, Chinese and Malays. They furnish the worst cases and the death-rate. This is wholly due to their mode of life, bad hygienic environment, the difficulty, if not impossibility, of persuading them to protect themselves by prophylactic measures, and, if they contract fever, to submit to treatment.

The Tamils are employed mostly in great gangs at railway and irrigation extension, quarrying granite, road building and as estate coolies.

The estate coolie is generally of a good type, is well fed, has fairly decent quarters and lives on open, cultivated, well drained coffee and other estates. The proportion of them who have fever is small. If they could be persuaded to use mosquito nets no doubt it would be still further reduced.

The more the country is opened up, cultivated, and drained by the planters the sooner fever will diminish in large districts. I consider the planter, from the hygienic standpoint, a blessing to the country.

Turn from this comparatively pleasing picture to the masses of Tamils at work on railway extension and quarrying and what one sees is deplorable.

Men, women and children living and working under conditions a few degrees higher than their brutes, and most of them martyrs to fever. That Malaria is so general and lethal amongst them is due, I think, to their habits and the conditions under which they work.

The immigrant before leaving India is advanced a certain sum of money. The first few months of his time in the Peninsula he is engaged in repaying it. To do this he starves himself and his family. Or else he half starves himself because he has not brought his women to cook for him. His children old enough to work and he himself never lose an hour at the quarries or extensions if they can help it. If fever sets in they stop work till the crisis is past, then begin again. Quinine is given haphazard except in hospital. When they become weak and cachectic they are perhaps persuaded to go to hospital, but rarely to remain till they are wholly rid of parasites and their health built up.

The habits of the Tamil coolie are filthy. Give him a mosquito curtain and he straight away uses it as a loin cloth and thus saves himself the cost of his slender wearing apparel. He will drink dirty water near him rather than clean water far off. Ankylostomiasis is common to almost all of them. Dysentery and diarrhœa complicate Malarial infection. Nature's calls are answered on the spot, and so no place but is a breeding ground of disease. (See Observations Nos. 1 and 13.)

Amongst many of the intelligent laity it is held that Malarial fever is due to the disturbance of disintegrating granite and red surface earth. This view is superficial.

Undoubtedly fever does become general and severe amongst the coolies engaged at such work and tends to spread over the neighbourhood. But in every instance brought to my notice where fever was unknown in a neighbourhood before the soil was disturbed I have found that the coolies brought in to work were infected. (See Observations Nos. 1 and 13.)

Given infected coolies, abundance of Anopheles, no mosquito nets, the hours between sunset and midnight spent in the open air, and fever will riot through any mass of men, women and children at any kind of labour.

One has only to turn to Jeram (Obs. No. 2) to see how a body of men engaged at the innocent occupation of recovering from beri-beri will nevertheless contract fever. These patients are provided with mosquito nets but they will spend the hours between sunset and nine or ten p.m. in the open air. Anopheles abound and are undoubtedly infected judging from several I found containing blasts or zygotes.

The tin mines are ideal fever spots. Most of them are shallow surface diggings which when worked out retain slowly moving or stagnant water and become the breeding places of myriads of Anopheles. I have rarely examined one unsuccessfully. These collections of water cannot be dispensed with. They are used for ore washing.

This with the Chinese coolie huddled by hundreds in his kongsi or messhouse establishes a Malarial circle. Each couch in the kongsi is separated from its neighbour by an excuse for a mosquito curtain. So that amongst the Chinese who form so large a percentage of the population Malarial fever runs riot.

The large employers of labour make some attempt to supply their coolies with mosquito nets. But this prophylactic measure is nullified by the habits of the labourer.

Most Chinese have at one time or another entered the country as contract labourers to work at the tin mines and it is from amongst these that half of the fever cases arise. The Chinese of the well drained towns are not so frequently infected.

The mining coolie works all day in the hot tropical sun. So that at sundown when the air is cool and inviting, and well on till midnight he scorns such a thing as a hot, half net-protected couch. Given such conditions, and the presence of infected Anopheles and fever will run through the kongsies like fire through grass.

Amongst the Malays living in large centres whose hygiene is directed by Europeans, Malarial fever is not common. But in many of their kampongs it is a pest. (See Observations Nos. 3 and 12 for example.) The Malay Policeman is also a capital forwarding agent of the various types of para-

TABLE I.

Monthly Return of Malarial Fevers, Federated Malay States and Straits Settlements, 1899.

Months.	Jan.		Feb.		March.		April.		May.		June.		July.		August.		Sept.		Oct.		Nov.		Dec.		Totals.	
PERAK.																										
Population 294,297.																										
Mean Temperature	77.1		78		78.2		79.3		79.7		80		80.6		79.6		78.9		78.3		77.3		77.1			
Mean Humidity	84		80		82		77		82		77		75		78		82		82		86		86			
Rainfall in inches	16.44		10.38		17.99		11.73		11.30		13.66		1.54		10.55		10.18		17.47		17.35		13.76			
Admissions and Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.
Intermittent	356	6	267	3	371	3	267	3	332	7	363	2	377	11	353	7	315	9	434	10	362	2	416	10	4,171	81
Remittent	33	11	22	12	23	6	39	6	37	7	49	10	47	13	42	11	43	10	38	7	52	7	49	13	476	120
Pernicious	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Cachexia	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
SELANGOR.																										
Population 90,000.																										
Mean Temperature	80.4		80.3		80.7		80.9		80.7		80.6		80.6		80.7		80.4		80.5		79.9		80			
Mean Humidity	83		79		80		79		83		81		74		76		79		78		79		80			
Rainfall in inches	7.87		3.79		8.3		7.15		13.83		5.38		2.31		2.56		12.38		8.44		7.27		10.12			
Admissions and Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.
Intermittent	92	...	94	...	84	...	128	1	171	1	195	2	137	...	149	...	109	...	137	...	110	...	...	...	1,546	4
Remittent	8	6	4	1	7	4	4	2	14	4	11	6	12	5	7	3	8	3	13	4	10	4	...	...	98	42
Pernicious	2	...	1	...	4	...	4	...	1	1	...	1	1	...	1	...	1	...	1	...	3	...	...	...	19	2
Cachexia	30	11	18	1	23	3	33	4	40	8	40	6	45	3	39	15	43	8	36	6	40	2	...	...	393	74
NEGRI SEMBILAN.																										
Population 82,876.																										
Mean Temperature	79		81		80		76		79		79		77		79		75		76		78		80			
Mean Humidity	83		80.6		84		86		86		89		90		91		91		91		89		88			
Rainfall	32.51		11.59		30.08		30.98		44.91		13.07		14.06		23.71		28.13		30.69		47.44		34.32			
Admissions and Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.
Malarial Fever	40	1	13	...	16	1	32	2	30	...	36	...	42	...	28	...	26	3	43	1	33	1	17	2	380	11
Intermittent	60	...	29	...	22	...	22	...	13	...	32	...	24	...	18	...	26	...	18	...	24	...	24	...	322	...
Remittent	25	...	10	...	12	...	10	2	9	1	20	...	10	...	13	...	12	...	9	...	13	2	14	...	157	4
Pernicious	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Cachexia	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
PAHANG.																										
Population 73,000.																										
Mean Temperature	79.7		80		81		83		83.2		81.2		82		82.2		82.4		82.7		81.5		82.5		Not recorded.	
Mean Humidity																										
Rainfall in inches	8.7		7.82		8.22		7.07		10.74		8.02		2.76		9.32		3.77		14.05		12.59		13.44			
Admissions and Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.
Malarial Fever	...	...	...	...	...	...	...	...	1	1	...	...	...	...	...	...	...	...	1	...	1	...	...	...	3	...
Intermittent	27	...	24	...	29	...	42	...	18	...	21	...	21	1	18	...	26	...	15	1	26	...	23	...	380	3
Remittent	3	2	1	...	1	...	1	...	2	...	2	1	7	...	3	2	2	1	...	...	1	1	4	2	29	9
Pernicious	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Cachexia	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
SINGAPORE.																										
Population 233,110.																										
Mean Temperature	77.7		78.2		78.4		80		81.3		80.3		81.8		80.7		80.4		79.6		79.1		78.1			
Mean Humidity	84		79		84		81		79		80		78		79		78		81		81		86			
Rainfall in inches	11.82		1.36		13.71		8.80		3.16		5.13		3.16		5.73		11.04		5.96		14.07		14.32			
Admissions and Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.
Intermittent	34	...	16	...	30	...	42	...	29	...	39	...	62	...	55	...	33	...	33	...	66	...	69	...	552	...
Remittent	20	6	10	4	17	4	11	1	36	3	13	4	9	9	12	2	8	3	17	9	9	3	9	3	173	56
Pernicious	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Cachexia	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

TABLE I.—*continued.*

Months.	Jan.		Feb.		March.		April.		May.		June.		July.		August.		Sept.		Oct.		Nov.		Dec.		Total.	
PENANG.																										
Population 159,703.																										
Mean Temperature	79		79		78·9		78·3		80·9		80·4		81		79·4		79·2		80.1		79·4		79·3			
Mean Humidity	85		85		89		88		79		74		79		83		83		81		81		83			
Rainfall in inches	5.22		2.08		3.39		4.95		15.23		6.91		9.12		24.08		22.87		12.03		14.82		5.8			
Admissions and Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.
Intermittent	39	...	32	...	29	...	24	...	44	1	58	...	50	...	36	...	42	...	39	...	32	...	40	...	465	1
Remittent	7	3	...	...	7	3	7	5	7	2	4	3	12	3	8	5	5	...	6	1	4	3	4	2	71	32
Pernicious	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Cachexia	6	2	4	4	6	3	8	5	7	6	11	5	6	4	4	1	2	2	2	...	4	1	5	1	65	32
MALACCA.																										
Population 96,856.																										
Mean Temperature	79·9		79·9		79·6		79·5		80		79·8		79·7		79·5		79·6		79·6		79·1		80.2			
Mean Humidity	93		93		93		95		95		94		93		94		94		95		94		94			
Rainfall in inches	7·94		1·07		5.17		7·03		9·58		7·88		3·54		9·46		7·66		6.13		7.60		7·08			
Admissions and Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.
Intermittent	48	...	25	...	17	...	46	...	71	...	90	...	86	...	79	...	54	...	64	...	65	...	69	...	714	...
Remittent	1	1	2	1	...	...	...	...	3	2	6	2	11	4	5	2	6	1	6	2	2	1	...	...	42	16
Pernicious	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Cachexia	7	...	5	1	3	...	12	...	19	...	12	...	8	1	9	1	13	...	21	...	11	...	18	2	138	5
DINDINGS.																										
Population.																										
Mean Temperature																										
Mean Humidity	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Not recorded.	
Rainfall in inches																										
Admissions and Deaths.																										
Intermittent																										
Remittent	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	90	
Pernicious																										
Cachexia																										
PROVINCE WELLESLEY.																										
Population 111,335.																										
Mean Temperature	79·7		79·8		80·5		81·3		79·9		81·7		82·6		81·3		81·6		81·5		80		80·7			
Mean Humidity	77		74		79		76		80		77		76		80		79		80		81		79			
Rainfall in inches	5		4.06		11.60		8.37		14.46		2.82		7.88		16.70		17.51		14.34		17.17		9.31			
Admissions and Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.
Intermittent	11	1	11	...	14	...	5	...	7	...	10	...	11	1	8	...	8	...	6	...	5	...	3	...	99	2
Remittent	1	...	1	1	...	...	3	1	2	1	1	...	...	...	3	...	3	...	1	...	1	1	1	...	17	4
Pernicious	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Cachexia	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

TABLE II.

Place and Nationalities.	Population.	Types of Malaria and Death-rate for 1901.														Total Cases.	Total Deaths.	Remarks.
		Quotidian.		Malignant Tertian.		Benign Tertian.		Quartan.		Intermittent.		Remittent.		Undescribed				
		Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.	Admissions.	Deaths.			
SINGAPORE:																		
Europeans ...	5,824																	
Eurasians ...	4,220																	
Chinese ...	164,041	—	—	—	—	—	—	—	—	337	7	174	36	—	—	848	83	Not Classified according to race or fever 1901.
Malays ...	36,080																	
Indians ...	17,823																	
Others ...	2,667																	
Total Population ...	226,655																	
PENANG:																		
Europeans ...	11,080																	
Eurasians ...	19,095																	
Chinese ...	98,402	—	—	—	—	—	—	—	—	868	1	149	67	—	—	1,013	68	This figure include Dindings.
Malays ...	106,000																	
Indians ...	36,051																	
Others ...	2,677																	
Total Population ...	273,307																	
DINDINGS:																		
Europeans ...	1																	
Eurasians ...	3																	
Chinese ...	3,653	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	See above.
Malays ...	5,866																	
Indians ...	477																	
Others ...	12																	
Total Population ...	9,113																	
PROVINCE WELLESLEY:																		
Europeans ...	103																	
Eurasians ...	193																	
Chinese ...	46,026	—	—	—	—	—	—	—	—	64	—	17	2	13	3	96	13	Not Classified according to race or fever 1901.
Malays ...	68,648																	
Indians ...	19,674																	
Others ...	320																	
Total Population ...	115,164																	
MALACCA:																		
Europeans ...	72																	
Eurasians ...	1,296																	
Chinese ...	19,468	326	—	8	—	—	—	—	—	—	—	30	11	274	24	760	35	—
Malays ...	51,978																	
Indians ...	1,276																	
Others ...	81																	
Total Population ...	95,467																	
PERAK:																		
Europeans ...	861																	
Eurasians ...	391																	
Chinese ...	149,173	—	—	—	—	—	—	—	—	—	—	—	—	8,207	167	8,207	167	—
Malays ...	144,783																	
Indians ...	34,770																	
Others ...	1,213																	
Total Population ...	331,191																	
SELANGOR:																		
Europeans ...	467																	
Eurasians ...	376																	
Chinese ...	108,768	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4,064	197	—
Malays ...	40,364																	
Indians ...	10,746																	
Others ...	815																	
Total Population ...	167,536																	
N. SEMBILAN:																		
Europeans ...	140																	
Eurasians ...	319																	
Chinese ...	32,901	329	6	31	1	—	—	—	—	—	—	24	—	390	6	4,169	13	—
Malays ...	56,917																	
Indians ...	5,326																	
Others ...	183																	
Total Population ...	95,976																	
PAHANG:																		
Europeans ...	131																	
Eurasians ...	46																	
Chinese ...	8,893	—	—	—	—	—	—	—	—	276	—	73	7	—	—	361	7	—
Malays ...	73,462																	
Indians ...	1,277																	
Others ...	340																	
Total Population ...	84,113																	

sites. Contracting fever in one locality he, when nigh dead, is shifted to another station and becomes a source of infection. I have been struck by this fact so often that I think it incumbent to point out that a Malarial case before removal from one station to another ought to undergo rigid treatment till his blood is relieved of all fever forms at any rate.

Degree to which the Various Types of Malaria prevail.

I have found Malaria of several types over all those parts of the Peninsula I have visited. From 200 to 300 cases have been personally examined and four and perhaps five types demonstrated. But it is difficult to form more than a rough estimate of the total fever rate of the Federation and Colony. At least 20% of the cases sent to me as Malarial have been excluded and other diseases, such as lobar and broncho-pneumonia, sepsis, hepatic abscess and tonsillitis ultimately diagnosed.

Of course a large number of cases must occur in the Malay communities and amongst the coolie class of Indians and Chinese that are not reported, so that so far as mere number is concerned the hospital returns for the past few years in the Federation and Colony are not under the mark.

The opposite tables are compiled from the annual reports of the various State and Colonial Surgeons for 1899 and 1900.

Few of the cases in this table were clinched by a blood examination. Most of the intermittent cases reacted to quinine and tonic treatment; thit is the only guarantee of their reliability. But the table is valuable in that is indicates the death-rate from fever. So far as the i termittent is concerned it is the death-rate of a Malaria that in the great majority of cases promptly reacts to quinine.

From personal observation I can testify to the marked and general prevalence of Malarial fevers in natives in the following foci. The types of fever in each focus are bracketed after the place name:—

Malacca (Map C. 5) *See Observation No. 8.*	*Malignant Tertian.* *Quartan.* *Benign Tertian.*
Jugra (Map C. 5) *See Observation No. 1.*	*Malignant Tertian.* *Benign do.*
Klang (Map C. 5) *See Observation No. 15.*	*Malignant Tertian.* *Benign do.* *Quartan.*
Ampang about four miles from Kwala Lumpor (Map C. 4)	*Malignant Tertian.* *Benign do.*
The railway line between Kwala Lumpor (Map C. 4) and Kwala Kubu (Map C. 4)	*Malignant Tertian.* *Benign do.* *Quartan.*

KAJANG railway extension (Map C. 5)	*Malignant Tertian.* *Benign do.*
JERAM (Map C. 5) *See Observation No. 3.*	*Malignant Tertian.* *Benign do.*
KWALA SELANGOR (Map C. 5) *See Observation No. 4.*	*Malignant Tertian.* *Benign do.* *Quartan.*
LOBO BLEDA near K. LIPIS (Map D. 3) *See Observation No. 13.*	*Malignant Tertian.* *Benign do.* *Quartan.*
DINDINGS (Map B. 3) *See Observation No. 5.*	*Malignant Tertian.* *Benign do.*
TEMERLOH (Map D. 4) *See Observation No. 13.*	*Malignant Tertian.* *Benign do.* *Quartan.*
KWALA KUANTAN (Map E. 3) *See Observation No. 13.*	*Malignant Tertian.*
The MALAY KAMPONGS near PEKAN (Map E. 4) *See Observation No. 13.*	*Malignant Tertian.* *Benign do.* *Quartan.*
BUKIT TIMAH, the Waterworks extension, and the native estates near SINGAPORE (Map E. 6) *See Observation No. 14.*	*Malignant Tertian.* *Benign do.* *Quartan.* *Pigmented Quotidian.*
TANGLIN BARRACKS in SINGAPORE (Map E. 6) *See Observation No. 14.*	*Malignant Tertian.* *Benign do.* *Quartan.*
KWALA MUAR in JOHORE (Map D. 6) *See Observation No. 8.*	*Malignant Tertian.* *Benign do.* *Quartan.*
TRAS (Map C. 4) *See Observation No. 13.*	*Malignant Tertian.* *Benign do.* *Quartan.*

I have found a number of Malignant types in all these foci. It is rare to find single infections in the Malignant cases, they are almost always multiple, no doubt due to the fact that the native is constantly exposed and rarely seeks hospital treatment till he is unable to work.

The incubation period appears to be about 10 days (see Obs. 1 and 3).

The Age of those chiefly Affected.

The youngest Malarial subject that I have examined was a three months old girl, the oldest a Chinese coolie aged 63.

In the Malay kampongs where Malaria prevails I have invariably found the younger members of the community the greatest sufferers.

Observations Nos. 13 and 15 illustrate this fairly well. In Kwala Selangor, particularly, fever amongst the adults is rare compared to children and adolescents.

On the other hand, in Malacca town, where fever is rare, the children exhibit no signs of fever nor do they give a history of having had it (Obs. 8).

In Malarial foci where the population is mostly Tamil I have found that all members of the community suffer apparently equally (Obs. 1). The immunising process of long and continuous residence that seems to occur in the adults of the Malay communities does not seem to take place in the shifting adult Tamils and Chinese.

The Anopheles Mosquito and its Relationship to Malaria.

Either at once or on a second visit to any part of British Malaya I have found several species of Anopheles. When I first visited Jugra (Obs. 1) in July, 1900, I found neither larvæ or ærial forms. But there had been heavy rains for sometime previous and it is probable that the breeding places were washed out. Later on I found A. superpictus and A. species *a* and *b*. Larvæ at this time were plentiful, a trained assistant bringing me three species which developed into A. superpictus and A. species *a* and A. species *b*.

In Jeram (Obs. 3), K. Selangor (Obs. 4), the Dindings (Obs. 5), Setiawan (Obs. 6), Pulu Lumut (Obs. 7), and Penang (Obs. 8), Singapore (Obs. 14) and along all the main lines of travel I have found them in varying numbers.

In Taiping (Map B. 3) itself I was not able to find any on my visit in December, 1900, but along the streams that flow down the hills behind it I found three species of Anopheles larvæ in the small rock pools at altitudes varying from 200 to 1,600 feet.

There is no doubt that several species Anopheles are widely distributed over British Malaya. Mr. Wray, Curator of Perak Museum, whose Colonial Office collection of Anopheles was pronounced one of the best by the British Museum authorities, informs me that he has found several species all over Perak.

Unfortunately a classification of his collection has not yet been issued. But personally I have found the Anopheles sinensis; a large black species with two black spots on the anterior margin of its wings which I am not able to identify; A. superpictus and A. species *a* and *b* and, rarely, what I have recognised as A. costalis and A. Rossii in various parts of the Peninsula.

In several places such as Setiawan (Obs. 6), the European quarters of Kwala Lumpor, A. superpictus and A. species *b* abound and yet no Malarial fever obtains. This would tend to show that Anopheles may exist in a locality and that locality remain free of fever. This is undoubtedly so, and is due to the fact that the Anopheles have not yet been infected by man.

But, generally speaking, in all centres of native population infected Anopheles are present, and the disease is by them chiefly propagated. Where the search is thorough I have rarely failed to find one or two in every ten or fifteen with blasts in their veneno-salivary glands or zygotes in their body cavities.

In mangrove swamps I have not yet found any forms of Anopheles although Culex abound. It is a common observation here that mangrove swamps are Malaria free.

I have not found Anopheles fastidious in the choice of breeding places. Almost any quiet shaded pool of any size or degree of dirtiness and even brackish pools along the sea shore are chosen for the deposit of eggs. In swiftly running water I have not, however, found them.

The results of experimental breeding and feeding on those infected will be published later.

Preventative Measures.

I do not propose to generalise on prophylactic measures against Malarial fever. It must be plain that preventative measures practicable and economical in Europe are not so in a country like this with so much virgin forest, a rainfall of over 100 inches per annum, square miles of flooded paddy fields and mining ground, swift wide streams, and a heterogenous collection of Orientals whose intelligence is coolie, and whose social and hygienic habits are as diverse or opposite as can be well imagined.

But there are a few specific measures that both Europeans and Orientals of all grades of intelligence can apply, or have applied to them by a wise administration that will go far towards preventing Malarial infection.

Europeans ought to accept the mosquito theory as the best working hypothesis to account for the propagation of Malaria. I will not offend common sense by insisting that the profession is fully acquainted with the entire life history of the Malarial parasites. But I do most positively insist as the result of personal observation over British Malaya that Manson, Ross, Celli and others are right in their view that Malarial fever is chiefly propagated by the Anopheles mosquito.

This being granted, the following preventative measures can and ought to be in a large measure carried out here :—

First, clearing, drainage and cultivation of the ground.

Planters as a class are doing this and in the progressive enlargement of the towns and stations, such efficient prophylactics are becoming more influential in stamping out Malaria.

It would, of course, be economically wrong, besides impossible, to clear and drain the whole of British Malaya. But it is certain that such capital measures should be carried out in the vicinity of all outstations as well as in and about the larger centres of population.

Any community or individual who to-day tolerates useless collections of water or close growing jungle near its or his dwelling cannot have grasped the danger of it.

Clearing and drainage, though undoubtedly the best measures to prevent the multiplication of Anopheles' larvæ, can be carried out here on a limited scale only.

Collections of water, such as abound in and about the mines and paddy fields are of great economical value and cannot be run off without wrecking industries. Breeding of fishes in them is next to impossible and has, when done in other places, not proved to be a successful measure against larvæ. But I have certainly observed in the vicinity of actively worked tin mines many abandoned holes containing water and breeding Anopheles that ought to be drained or filled in. Such collections of water are more dangerous than those others in constant use and having a current.

It should be a standing rule that miners' kongsies be built on as high ground as possible and not close to such collections of water.

On all railway extension such as that at Kajang the higher ground should be chosen for kongsies, the jungle ought to be cleared for at least fifty yards on all sides and no water-holding depressions tolerated. The initial cost of such will be small compared to the loss through absence from work of coolies contracting Malaria under the casual conditions that now obtain.

Instead of, at quarries such as those of Jugra, putting coolie lines on the lower ground it would be wiser to build them on the well drained hill sides.

The Police Barracks of outstations such as Sanka Dua are centres of Malaria, and from them it is radiated over the length and breadth of the country. It should be a rule to place them high on well cleared and well drained ground. It is really pitiful the extent to which Malarial fever prevails amongst police constables, a class of the community most amenable to preventative measures.

Protective Measures against Anopheles' Bites.

Mosquito netting stands in the front rank. Its value, over beds, is fully recognised by the intelligent individual and the authorities.

But it is time that both the individual and the Government insisted on the mosquito house.

All Government Bungalows, Sanitoria and Rest Houses ought to be provided with roomy, comfortable, verandah, mosquito houses. Made of cotton gauze netting they are next to useless. Fine wire gauze, though more expensive, is cheaper in the end, as well as being at all times more effective.

Large hospitals should have a fever ward protected by revolving doors, and stationary window screens of wire netting. Each bed should be protected by a mosquito house rather than by the ordinary net.

In my investigation here I have repeatedly found that a Malarial case has infected several patients in the same ward.

In only two hospitals in the Federation, Jeram and Raub namely, have I found mosquito nets in use.

I have never found mosquito nets in use in Police, Guides or Infantry barracks. In nearly every police barracks visited I have found Malaria rife, and pitiful requests from the inmates for transfer to another post. This is in large measure needless. A police or other barracks unprovided with mosquito nets or houses indicates either a want of confidence in the advice of the Medical Staff employed by Government or an empty treasury. I cannot believe that it is due to the cost of nets being of greater moment than the health of the force.

I have so far enumerated only those instances where it appears that the individual can help himself or be aided by a paternal Government.

But this leaves a class not so readily dealt with, the great body of coolie labour, namely,

The Mining Class.—The great majority of this is composed of Chinese. In most of the kongsies I have found mosquito nets the rule. I should say apologies for mosquito nets. They are torn and narrow, and a restless sleeper has generally one or more limbs close up against their sides. Of course he is often bitten under such circumstances.

This is bad enough, but it is more regrettable that the mining coolie who, after a laborious day in the mines, insists on freedom from sundown far into the night.

In one of the most notorious Malarial camps I asked a Chinese employer of labour: "What will be the result of building a mosquito proof kongsie and a compulsory rule that all coolies must be inside by sundown?" "An immediate bolt of the whole number to where their habits will not be interfered with" was, in substance, his reply.

Therein lies the difficulty of protecting large numbers of coolies by even the best devised Government measures.

The Other Labouring Class.—This is largely composed of Tamils. I have not yet seen a Tamil coolie protected by a mosquito net. At such large extension works as Kajang, or quarrying as at Jugra (Obs. 1) there is no attempt on the part of the individual to protect himself from Malarial infection except by the use of the smudge. This is wholly inadequate, as witnessed by the large amount of Malaria prevailing in those places.

At railway extension work the kongsies are temporary and are often carried forward towards the head of the cutting. Therefore they are flimsy structures, but charming haunts for the mosquito of all species. They are generally in the midst of pools that breed Anopheles larvæ.

Like all inhabitants of the Peninsula the idea of sequestering himself from sundown to sunrise is obnoxious to the Tamil coolie. It is his joy time, and I doubt if he could under any circumstances, except a large increment of intelligence, be made to see the advantage of early retirement to a protected kongsie.

Without some co-operation on the part of the coolie I do not well see how the large body of them are to be protected against the bites of Anopheles.

I have put the difficult side of the question first. But there is another more hopeful view.

My observations convince me that permanent coolie lines as at present constructed and situated are improveable in the measure of protection they afford to their inmates.

Their general hygienic arrangements should be as systematically carried out as they are in the large police and other barracks.

They should if possible be situated on high or easily drained ground, and for sixty or seventy yards on all sides no growth except a few shade trees should be tolerated. A sort of courtyard would thus be formed where evening recreation could be had without danger from the bites of venturesome Anopheles.

If the quarters themselves were provided with wire-gauze over all openings and a wide gauze-protected verandah the danger of Anopheles' attack would be reduced to a minimum.

I consider it essential, too, that a keeper be told off for each line to see that it is kept clean, that water is thrown into drains and that no rubbish be allowed to collect.

If such measures were consistently carried out there would not only be less Malarial fever, but also Dysentery and Diarrhœa to waste the coolies and hard press the Government for labour.

Other Measures.

Kerosine Oil.—The application of this as a measure to exterminate the larvæ of Anopheles is of but limited application in this country with its heavy rainfall. To be effective it would have to be mixed with the clouds.

My experience is that where oil can be employed it would be cheaper, cleaner and more effective in the long run to blot such places out by filling.

Quinine as a Prophylactic.

In hospital I have never failed to destroy the fever forms of any of the parasites by the proper exhibition of quinine. I will not discuss this point further as Dr. TRAVERS has undertaken to do it for me in a separate paper.

But my experience of quinine both in treatment and as a preventative measure on a small scale firmly convinces me that it could be used to good effect on the coolies engaged at extension and other large works either alone or as a measure supplementary to others.

I would recommend that at Kajang and Jugra for instance, the coolies be paraded in the evening or morning or both and be made to take ten grains of quinine.

This procedure has been lately tried by Dr. MIDDLETON at Kallang (Obs. No. 13) near Singapore with good results.

In conclusion it may be said that it is as dangerous to generalise on preventative measures against the bites of Anopheles as it is to generalise on the treatment of the fever propagated by them.

Each fever case should be miscroscopically diagnosed and treated intelligently. The *olla podrida* of all hospital cases and their unthoughtful treatment by quinine, when quinine can be thoughtfully and effectively used, smacks of snap diagnosis and ignorance of the physiological action and virtue of the drug.

CELLI's recent experiment in net prophylaxis would appear to indicate that that method is the best to combat Malaria here. But his admission at the end of his paper that after all said and done the ideal prophylaxis is effective disinfection of the blood, would indicate that his net experiment was no more than an experiment difficult to practically apply generally and effectively.

European and the intelligent of the Orientals have been for a long time net protected here. Malarial fever is not more common here and is much less difficult to control than many other diseases. The great mass of the population are Chinese and Tamils of the lowest grade. It would be impossible, except by police control, and that is impossible, to make them use mosquito nets and houses and be within them at the proper time.

What is needed is the best of ordinary sanitary precautions; hydrolic drainage, clean surroundings to houses and coolie lines, and a well regulated passion for quinine.

I cannot close without paying a tribute to the following gentlemen who have, through their interest in the Institute, assisted me in gathering data for this preliminary report :—

To Mr. W. H. TREACHER, C. M. G., Acting Resident-General, Federated Malay States, for his courtesy in arranging for my visits to the Colony. To Mr. C. W. SNEYD-KYNNERSLEY, C. M. G., Resident Councillor, Penang, who, anticipating my arrival in Penang, arranged for my visits throughout his jurisdiction. To Mr. E. M. MEREWETHER, Acting Resident Councillor, Malacca, who was equally thoughtful. To Mr. HUGH CLIFFORD, C. M. G., British Resident, Pahang, for much personal help during my observations in this State. To Drs. FREER, MUGLISTON, LEASK, DANE and MIDDLETON, of the Colonial Medical Staff, and Capt. ROBINSON, R. A. M. C., for information freely given and for the trouble taken to collect Malarial cases for me. To Dr. TRAVERS, State Surgeon of Selangor, Dr. FOX, of Perak, DR. GIMLETTE, of Pahang, and Drs. MCCLOSKY and WATSON of Selangor for the cases they supplied me.

Observation No. I.

Jugra (Map C. 5) is a district of Kwala Langat. It lies on the east or mainland bank of the mouth of the Langat River. Separated from the sea by one or two miles of mangrove swamp is a moderately high granite hill. Along the base of the latter and between it and the swamp is a new road. Every half mile or so on the hill side of the road is a quarry of disintegrating or solid granite. Tamil coolies work the quarries at present. These with their families, a few Chinese shop-keepers and native officials make up the community. In the neighbourhood but two miles from the quarries is a Malay village.

Since May, 1898, Jugra has borne a bad name. Scores of Chinese and Tamil coolies, a few shop-keepers and one or two native hospital dressers have died, while many others of all nationalities are said to suffer from a severe type of Malaria. (See following Table.)

Table of Fever Cases at Jugra.

Number of Fever Cases Indoor from May, 1896, to 31st December, 1900.		Number of Fever Cases Outdoor from May, 1896, to 31st December, 1900.	
1896	69	1896	8
1897	255	1897	30
1898	507	1898	90
1899	472	1899	148
1900	435	1900	168

It is a common opinion in the East that Malaria is somehow associated with the opening up of disintegrating granite. On this assumption it was proposed to close the quarries.

In the hospital I found eight Tamils who had been admitted with fever. I examined the blood of one of them admitted June 16th (his temperature was 104.5) and found numerous smallest size rings and discoids in four slides, but only a few mature pigmented Malignant Tertian parasites. Quinine was ordered not to be given.

June 17th, 9 a.m.—Temperature 104.5.—Numerous smallest size rings and discoids in four specimens, but only a few mature pigmented parasites. Pigment is fine. The granules are few and peripherally situated; they oscillate rapidly.

6 *p.m.*—The rings and discoids slightly enlarged are still numerous; occasionally a ring breaks into an actively pseudopodic organism. No pigmented forms to be seen, but a few pigmented leucocytes are now present.

June 18th, 10 *a.m.*—Numerous, moderately large, slightly pigmented, almost quiescent parasites about one fourth the size of the red corpuscles. Pigment is fine, granules numerous, they oscillate rapidly in the periphery. The invaded red cells are not noticeably decolorised but are slightly shrivelled. A few are noticeable brassy. A small number of pigmented multinuclear leucocytes present.

6 *p.m.*—The parasites have slightly enlarged since 10 a.m.

June 19th, 8 *a.m.—Temperature* 102.3.—Parasites not so numerous as at last examination. But they have grown slightly and occupy about a third of hosts. Only occasionally is a parasite seen whose pigment is quiescent.

I watched the specimen of blood taken at 8 a.m. and at the same time fresh specimens every half hour till a rigor set in at 10 a.m. In none of them was I able to detect spore formation. It was not rare to see true crescents and ovoids of the crescent series. No flagellated bodies seen.

This patient had typical cold, hot and wet stages on the 21st, 23rd and 25th of June. His blood frequently examined showed typical Malignant Tertian parasites in at least two different stages of development. He was given 20 grs. of quinine on the 25th as his temperature began to descend, and an anticipating dose for the following four days. The temperature remained subnormal.

It is an interesting fact that few cases coming into this hospital for other diseases than fever develope it after admittance. None of the hospital inmates have mosquito bars.

There is considerable difficulty in persuading the Tamil coolies to leave their work when it is known that they have fever. The reasons for this will be pointed out later. At the quarries and coolie lines I found 41 men, 15 women, and 23 children ranging in age from three months to twelve years, in the coolie lines.

All but four of the men had enlarged spleens; six of them very large hard ague cake. All except two had a history of fever and have been in hospital for a day or two at a time, or till subsidence of fever under quinine.

I found seven men in coolie lines suffering from fever, or the effects of recent attacks. Examined one on the spot. He had a temperature 99.4 F. History of ague in early morning, spleen very hard, extending almost to midline. In three specimens of blood I found two parasites one quarter to a third the size of their hosts. They contained fine pigment granules in the periphery and were actively pseudopodic. The infected corpuscles were slightly pale and enlarged. This man has had fever recurring every second

day for a week past. He would not take quinine. Many of his red cells were extremely small. I observed numerous pigmented mononuclear leucocytes but no form of the crescent series. This and the detailed case may be taken as a fair example of the kind of fever existing among the coolies; single and multiple Malignant and mild Tertian infections.

Of the twenty-three children examined all were anæmic and nineteen of them had enlarged spleens. Two boys, one seven and the other five, had enormous abdomens with spleens reaching across the middle line. These children are rarely taken to hospital for treatment. The result is that they are seldom free of fever and the mortality from cachexia is great. I found a seven months' old boy with a temperature 103.4 in the cold stage of fever lying on the floor protected by a cotton cloth. His blood contained numerous small unpigmented amœbulæ, and a few large sized pigmented parasites of the Benign Tertian variety.

I was informed that prior to the opening of the quarries in 1896 little fever was known amongst the Malays of Jugra. The Malays firmly believe that to the opening of the quarries is due the fever now so rife amongst them. But this can have been only an indirect cause in that it brought infected coolies into association with the Anopheles of Jugra, as will be pointed out later.

In Jugra then there are at present two types of fever; Benign and Malignant Tertian showing in the adults and infants of both sexes. A significantly large number of infected Tamil children support Koch's observation. (See table) :—

Nationality.	No. Examined.	Men.	Children.	No. with signs of Fever.	Men.	Children.
Tamils	64	41	23	58	39	19
Malays	18	Nil.	18	4	Nil.	4

It was only natural that I should expect to find Anopheles in abundance in Jugra. In a thorough search, however, I failed to find any forms of Anopheles. The surrounding jungle and the neighbouring mangrove swamps swarmed with several species of Culex and many of their breeding-places were discovered.

The quarry that was being worked during my visit is situated on an open hill side. The jungle had been well cleared in the neighbourhood of it. There was no stagnant water about. A small clear stream ran close to the quarry and furnished drinking water to the coolies. I followed it up for 300 yards or so, but found no larvæ of any kind in it although the jungle swarmed with Culex.

I was surprised on not discovering any Anopheles. With so many cases of fever or with a history of fever it seemed that one ought to find some evidence of them. There had been heavy rain for the past few weeks and it is probable that the Anopheles' breeding-pools had been washed out.

The absence of Anopheles only superficially appears to support the commonly held view that the disturbance of disintegrating granite is a cause of Malarial fever; a view that has frequently led the Government to close down quarries similar to these.

But there are many positive facts against such a theory while my failure to find any other cause, or Anopheles in any form is simply negative evidence, and is a remarkably exceptional instance altogether, to be accounted for, I think, by the heavy rains having washed out the breeding-pools.

In the first place Malaria persisted after work was stopped on the disintegrating granite though continued on the solid granite a mile away.

Further, the following history of the first batch of coolies brought in to open up the quarries is wholly against the granite hypothesis, and shows, I think, most conclusively how a neighbourhood free of Malaria may become infected.

In May, 1896, there was brought into Jugra a batch of 300 Chinese and Tamil coolies who had worked in various parts of the Malay Peninsula for some time previously. They were a sickly lot and many of them had had Malarial fever.

On their arrival at Jugra they began to clear the ground and blast. In three days several of the Chinese were down with fever, in five days a few Tamils. From the first the Chinese suffered more severely. They got little or no quinine, would not go to hospital, grew weak, became bad workers, and soon died off or left the district.

The Tamils continued to have fever, would not remain under treatment, became incompetent and also soon died off or removed. Almost the whole number of the original lot of coolies thus disappeared during the first two years.

In the meantime immigrant Tamils took their places and batches of them continue to come over from India from time to time. They nearly all had Malarial fever in India.

The immigrants are fever ridden and are in hospital soon after arrival. Scarcely one of them but is laid up occasionally with fever.

Shortly after the arrival of the first lot of coolies the Malays in the vicinity contracted fever. None of them had at any time worked in the quarries. They often pass the coolie lines, but only rarely do the coolies wander near their village two miles off.

In the above account can be found the clue to the general infection of Jugra district with Malarial fever.

The original lot of coolies must have brought the parasite with them, for it is scarcely probable that original cases of fever could have developed after only three or four days' work at the granite.

They undoubtedly infected the immigrants through the Anopheles that abound in the neighbourhood and the infection has been continuously propagated down to the present. (*See* a like history of a Malarial outbreak at Kallang, Obs. 13 and 14.)

The coolie lines were found singularly free from Culex. Perhaps on account of the great amount of smoke that continually circulates.

The hospital dresser's quarters swarmed with Culex, however. He had had several attacks of Malignant Tertian, and has since died of the disease. He could not be persuaded to use a mosquito net.

Since writing the above numerous Anopheles superpictus and species *a* have been found by a trained assistant sent by me to Jugra; and Dr. WATSON, District Surgeon of Klang, has also found them in abundance.

It is probable, as I supposed above, that the breeding-places had been washed out by the preceding heavy rain about the time of my visit in July, 1900.

Observation No. 2.

An interesting point in connection with the fever of Jugra is that an assistant of mine, after four or five days' malaise, had a rise of temperature exactly fourteen days after my return from Jugra. It was typically Tertian.

His temperature at 11.30 (August 5th) was 104.3. He abstained from quinine till I made a thorough examination of his blood. At 12.30 a.m., his blood contained many infected corpuscles. The plasmodia were small, active, but unpigmented. 2.30 *p.m.*—Plasmodia are slightly larger and actively pseudopodic. The pseudopods are long and slender. 5.30 *p.m.*—The hyaline bodies are still fairly frequent and a little larger. Only one seen with pigment situated peripherally. A few melaniferus white cells present.

August 6th, 10.30 *a.m.*—A few parasites filling half the corpuscle to be seen. All are finely pigmented but no less active than yesterday. Infected cells slightly enlarged and paler than normal.

August 7th, 9.30 *a.m.*—*Temperature* 102.3.—Only one mature form detected in peripheral blood; a typical Benign Tertian parasite. A few small hyaline forms present. His temperature reached 104.2 at 12 noon to-day. Grs. 20 quinine given at 12.30 p.m. and at 7.30 p.m.

August 8th, 10 *a.m.*—No fever to-day. Grs. 10 quinine morning and evening; no more fever.

The interest of this case lies in the fact that this assistant was the only member of my party to sleep on shore, and who did not take quinine. The rest of the party took quinine in 5 gr. doses and slept at sea. He slept at the quarry contractor's house within half-a-mile of the quarry and did not use a mosquito curtain. He had had no fever since July, 1889, and so thought himself immune.

The incubation period of his present attack was between nine and twelve days. The pyrexia and parasite developed (Benign Tertian) corresponded to that of the Benign cases seen at Jugra.

An incubation period of from 9 to 12 days appears to be the rule. (*See* Observation No. 3.)

Observation No. 3.

The following observation shows most conclusively the incubation period of Benign Tertian and its association with and propagation by Anopheles.

A new hospital for beri-berics was opened at Jeram (Map C. 4) in June, 1900. Many of the Chinese beri-berics contract fever on an average of eleven days after their arrival. The Chinese workmen during the building of the hospital and the Malays in neighbouring villages had suffered considerably from Malaria since 1897. The apothecary in charge, his wife and child were all down with fever within twelve days of their arrival. The fever was reported to me to be general but to quickly subside on the exhibition of quinine.

Jeram is a small Chinese and Malay fishing village at the mouth of a shallow creek. The beach is sandy and the water recedes for half-a-mile at low tide. Just above high water mark a road runs along the shore, here and there separated from the sea by thick mangrove swamp. Behind the road is dense jungle covering low wet ground. A mile along the beach from Jeram is the new hospital. I found it well built, on the landward side and only a few yards from the road. The sea at high tide reaches the opposite side of the road. Brackish water oozes up about the hospital in many places. Drinking water for the hospital is collected on a galvanized iron roof and run into covered tanks. Each patient's bed is protected by a mosquito house in good order. For fifteen yards behind and at the ends of the hospital the jungle has been cleared. But there has been left an irregular earth surface which holds from a cupful to twenty gallons of brackish water in the depressions. The hospital, neighbouring jungle and surrounding air swarms with mosquitoes just before and after sundown. I searched the brackish pools for Anopheles' larvæ. Scarcely a pool was free of larvæ of sorts. Some were so crowded with Culex as to form a dull brown moving pellicle upon the surface. In such no Anopheles were found. But in a pool just by would be found a few Anopheles' larvæ, and no Culex. Ten yards to the rear of the hospital I found a pool about four feet in diameter containing hundreds of Anopheles' larvæ and many rafts of eggs. Some of the eggs collected from several pools developed in due time into A. superpictus and A. species *b*.

In none of the Anopheles afterwards developed from larvæ was I able to squeeze blasts from their veneno-salivary glands; and a later microscopical examination of others developed from the same lot of larvæ disclosed no intestinal change.

An Anopheles superpictus amongst a lot of 33 caught on the hospital mosquito curtains contained blasts in its veneno-salivary gland.

There are but few children in Jeram village. Two that I examined had enlarged spleens.

The Chinese adults (mostly fishermen) declared that they never had fever before 1897. This bears out the report of Dr. TRAVERS, State Surgeon of Selangor, who says in his 1899 report: "The coast districts of Selangor "from the year 1890 to 1897 were extremely healthy, and Malarial fever "was a comparatively rare disease; it is now a very definite source of "discomfort and danger to the inhabitants."

There can be no question that Anopheles are at present the chief propagators either directly or indirectly of the fever amongst the newly arrived beri-berics. This is evident enough to throw into the shade consideration of any other cause.

I had many of the beri-berics under observation in the hospital at Kwala Lumpor for months before their removal to Jeram, thirty miles distant, and they were all free of Malaria. The fever is acquired at Jeram, and generally within eleven days of arrival.

It is impossible after a long, burning hot day to persuade the inmates of the hospital, who sleep most of the day, to take to their protected beds an hour before sunset. No one living here, let alone a Chinaman, but would rather spend the cool of the evening freely in the open air and so risk Malarial infection than harbour himself in the close hot quarters of a mosquito tent, after a sun-scorched day of the Malay Peninsula. And therein lies the difficulty of net prophylaxis in this country. Carried out generally as it has been carried out experimentally in Italy and elsewhere, life here would not be worth the living.

I examined the blood of two Jeram Malarial cases and found the parasites of the Benign and Malignant Tertian fever.

The apothecary in charge at Jeram has since my visit sent me five lots of mosquitoes indiscriminately taken from the curtains of the hospital beds. In the whole lot of one hundred and sixty-two I found six A. superpictus, and three that I have identified as species *b*. Only one, an A. superpictus, contained blasts in its veneno-salivary gland. I later on microscoped four of the other Anopheles and many Culex, but saw nothing remarkable.

Observation No. 4.

At Kwala Selangor (Map C. 4) I visited a large Malay village containing a thousand inhabitants. It is situated in a large coconut plantation just above high water mark. Between it and the sea is a dense mangrove swamp. The village is very old.

The Malay houses, like all in the Peninsula, are built ten or fifteen feet from the ground on a gridiron of bamboo supported by strong uprights. They are roofed with attaps and in this village are well protected from the elements. The houses lie discretely scattered along the main paths of a palm grove.

In the middle of the village is a school attended by forty children from seven to fifteen years of age. On the day of my visit I found them all collected together at lessons, except six who were absent sick from fever.

Of the thirty-four children six were found to have moderately enlarged spleens; two seven years old, two eight, one nine and two twelve years old. All six had a history of having had fever.

The school register showed that during

February,	1900	...	2	Children	had	had fever.
March	,,	...	11	,,	,,	,,
April	,,	...	6	,,	,,	,,
May	,,	...	10	,,	,,	,,
June	,,	...	6	,,	,,	,,
July	,,	...	10	,,	,,	,,
August	,,	...	10	,,	,,	,,
September	,,	...	8	,,	,,	,,
October	,,	...	5	,,	,,	,,
November	,,	...	27	,,	,,	,,
December to the 8th			6	,,	,,	,,

This is a large proportion, and fearing that fever might be no more than the best excuse to account for truancy, I at once visited the houses of the six December absentees. I found three of them with pyrexia all above 103 F., and three in bed suffering from exhaustion of recent attacks. All six had enlarged spleens.

The blood of one of the feverish boys was examined. Temperature 103.3 F. and falling. Many small active hyaline forms were seen, but no pigmented parasites. His father informed me that the feverish attacks were mild and came on every second day. When he had quinine he gave it and the fever would soon stop. This I find to be the general character of the fever amongst the children.

Certainly the finding of the December absentees with evidence of fever is favourable to the truth of the above statistics.

Only occasionally does an adult develope fever. But I find that quinine in liberal quantities is distributed by the State Surgeon and is taken freely by the older members of the village. It is difficult to induce children to take it.

The neighbourhood of the school was gone over thoroughly and I found a few collections of water breeding a small number of Anopheles superpictus.

I found several similar pools in the neighbourhood of the houses. About thirty yards from a large house in which fever often occurred I found a pool of rain water, green scummed with confervæ and containing a few Anopheles' larvæ. They developed into A. superpictus.

It struck me that Malaria in the village might be readily stamped out by quinine and net prophylaxis. Oil is out of the question, as the area to be covered is too large. All the water cannot be drained off as it is needed to flood the paddy fields. I found the beds in several of the better class houses equipped with nets. But the Malay who sleeps through the hot hours of the day will be in the open air at sundown and far into the night, so that the effects of his net is in some measure neutralised.

The percentage of children in this village subject to Malaria is large, yet the mortality is low, and even amongst those with a history of fever great splenic enlargement is rare; further they look robust. This is probably due to the recognised value and sometime use of quinine whereby the attacks are early suppressed. It is probable also that the use of quinine and a certain amount of acquired immunity may account for the little fever amongst adults.

Two grains given daily to the forty pupils I saw collected together would go far towards disinfecting their blood and rendering it proof against the bites of dangerous Anopheles.

Observation No. 5.

The Dindings (Map O. 3) :—

Here an arm of the sea, two miles wide at its mouth runs into the land, first due east for five miles, then north for fifteen to end in the Dindings river. The first five miles, hills of disintegrating granite from 300 to 1,000 feet in height rise up on both sides of the inlet. They are densely wooded (being forest reserve) except for a large clearing which marks the administration station of Lumut. In the interior behind the hills is, first, low ground scarcely above high water, and then swamp for twenty miles or so.

Across the mouth of the inlet four miles seaward is a noble-looking hilly island, Pangkor, mostly forest reserve. On the eastern or landward side is the old Government administration station abandoned in 1896 because of the severity of the Malaria.

Headquarters were removed to the mainland and are now established at Lumut five miles up and on the southern side the inlet of the sea. The Government have here a District Officer, Mr. HALIFAX, who aided me in every possible way to gather data.

A first-class hospital ward in charge of an apothecary is situated on a small bluff rising up from a sandy beach. The position is airy, attractive, and gets all of the breeze that blows. Here also is a well kept barracks sheltering some 50 Sikh policemen detached from the Penang force. The barracks is on a small bluff, is well air swept, and properly shaded. From fifty to seventy yards east of the barracks the bluff falls steeply into a two hundred acre swamp. To the west is a smaller area of swampy ground. The former ground is kept damp by a stream whose source is the overflow of the reservoir half-a-mile away and up the hill side, the latter by drainage from the adjacent hills.

The District Officer has not had fever in a residence of a year. He has an efficient mosquito house. All officers before him were martyrs to fever.

Every six months or so the Sikh police force is renewed owing to the members suffering from Malarial fever and its sequelæ. The fever is of the Benign and Malignant Tertian type. Many of the Malignant cases recorded in the Penang statistics are from this spot. The police force I saw was anything but sickly looking. But the fever amongst them has not been severe of late. In their barracks I caught many aerial forms of Anopheles superpictus. In the swampy ground to the east of the barracks, just where the small stream enters it, I found numerous Anopheles' larvæ

A few of these afterwards developed into A. superpictus. Their veneno-salivary glands were normal. Here, undoubtedly, is the chief breeding-ground of those Anopheles that serve to propagate fever amongst the Sikhs.

In the hospital were two Tamil estate coolies suffering from Tertian fever, one regularly, one irregularly intermittent. The blood of the latter case with a temperature of 100.1 F. and on the rise, contained some free pigment, a few pigmented leucocytes, many small pale red cells, a few rings and discoids and an occasional pigmented Malignant Tertian plasmodium.

The Apothecary assured me that no cases of Malaria develope in the hospital in those admitted for dysentery and other diseases. No nets are used by the patients. I found no Anopheles in eighteen mosquitoes collected in the ward and only three A. superpictus in forty-six collected in the barracks at the same time. One of the latter three Anopheles was infected.

It seemed to me that the Sikhs' barracks could be rendered mosquito-proof and the beds of the men protected.

The surrounding swamps ought to be drained. By looking at the Map it will be seen that aerial forms of Anopheles have a flight of only 50—100 yards from their breeding-pools to their feeding-ground in the barracks.

I am inclined to state very positively that drainage of the swamps of Lumut and net protection of the police would shortly clear the station of Malarial fever.

Observation No. 6.

Setiawan (Map B. 3) is a large Malay village at the bend of a branch of the Dindings river. It is about thirty feet above high water on flat unproductive ground. In the vernacular school I found twenty-three pupils. One aged eight years had a moderately enlarged spleen. He had often been for a visit to Pangkor Island and had been absent from school six times during the past year sick of fever. The other pupils were a fine healthy lot. There is little or no sickness of any kind in this village of about two hundred people.

No. of Children Examined.	Average Age.	No. with signs and history of fever.	Percentage.
23	7	1	4·3

In stagnant water along the roadsides I found numerous Culex, and in one cleaner pool, Culex in abundance at one end, and a few Anopheles' larvæ at the other. Near a Malay's house another small collection of water was found in half the outer shell of a coconut; in it were a few Anopheles' larvæ. In three other collections of water in hoof tracks a few Anopheles' larvæ were found.

Setiawan is an instance where Anopheles may be present and the place be free of fever. It supports a view that Anopheles are quite innocent till infected by man.

The children of this locality, as in all others that I have visited, are an index of the extent to which Malarial fever prevails. Setiawan is fever free; the children present no signs of Malaria.

Observation No. 7.

Pangkor Island (Map B. 3), because of the severity of Malaria, is regarded as lethal by officials and has passed into proverb.

On a hill about three hundred feet high and overlooking the sea I found the remains of the District Officer's house, abandoned in 1896. It was found quite impossible to risk the health of a man in it.

On the hill and neighbouring ground I did not find any Anopheles' breeding-grounds, but a few small collections of water in some old tins contained Culex larvæ.

A collection of shops, a Police Station, School House and a few fishermen's huts situated on some flat land just above a clean sandy beach mark the old administration station of the Dindings.

The low ground on which the village is situated is the beginning of a valley about a quarter-of-a-mile wide that broadens out into a large triangle of flat ground. Malay houses are scattered through it. A few small streams are fed by mountain springs and here and there render the valley marshy. But on the whole the ground was dry on my visit, the streams running and confined by low banks.

I went through this valley and found a few Anopheles' breeding-grounds; in half coconut shells carelessly thrown down, in small clear pools, in cart ruts and in depressions made by heavy buffaloes. A collection of water in a bent plantain leaf held seven larvæ. In the running streams I found none.

Considering that it takes at least six days for the Anopheles to develope from egg to imago I cannot help thinking that but few of all eggs deposited in the above collections of water would ever reach the aerial form of the insect. For with two or three days of hot sun and no rain, a frequent occurrence, they would be dry as tinder. This, probably, is the reason. I did not find an abundance of both aerial forms of Anopheles and Culex. Only a little rain had fallen for some time past and there were but few collections of water.

No cases of Malaria were found in either adult or infant Malays or Chinese, and the police records showed that only one man, the corporal, had been recently off duty for fever.

I examined 18 children and found only one with an enlarged spleen and a history of recent fever. The parents of several others gave a not clear history of the children having had fever.

No. of Children Examined.	Average Age.	No. with signs and history of fever.	Percentage.
18	6	1	5·5

My observation on this spot indicates that Malarial fever has been almost stamped out of Pulu Lumut.

Observation No. 8.

Malarial fevers are rife in Malacca province. Malacca town, on the other hand, is apparently free. In this small and ancient place are gathered together about thirty Europeans, many Straits and native born Chinese, a large number of Malays, a few Indians and numerous Eurasians bearing English, Dutch, Portuguese, Indian, Chinese and Malay names. The whole population is, nevertheless, as robust as any collection I have seen in the Peninsula. Malacca town itself is almost flat, compactly built and well drained. There are no waste places inside the town limits and no breeding-places for mosquitoes. On my visit in June, 1901, there were but few mosquitoes of any kind about, and no Anopheles could be found for me.

Dr. Croucher, the Colonial Surgeon, informed me that he has never seen a case of fever in a European that could be said to have originated in town.

Statistics would tend to show that Malacca town is fever ridden. But they are founded on unreliable police and other reports. Every roadside death and every case with a temperature not diagnosed as something else is put down as Malarial fever.

It is impossible for one qualified Medical Officer to watch every case of disease in a population the extent of Malacca, and his native assistants have not an iota of modern knowledge of Malarial fevers.

A fair index of the fever rate of Malacca town may be gathered from Tables Nos. 1, 2 and 3.

Table No. 1.

No. of Children.	Average Age.	History of Fever.	Splenic Enlargement.
252	11	6	Nil

Table No. 2.

193	12	6	3

Table No. 3.

16	14	2	Nil

Table No. 1 is founded on an examination of the children in the St. Francis School. This school is in the heart of the town and is attended by the poorer European, Eurasian, Chinese, Tamil and Malay children who come in from all parts of the town. Of 252 children with an average age of eleven, 38 of whom sleep under mosquito curtains, six had a history of fever. None of the six or the remaining 246 had spleens at all enlarged.

Table No. 2 is founded on an examination of 193 boys with an average age of twelve in the High School. This school is also centrally situated. The great majority of the pupils are of well-to-do parents from all over the town. There are a few Europeans, many Eurasians, Chinese, and a few Indians and Malays. Six pupils had a history of fever, three of them had slightly enlarged spleens. None of the other 187 had splenic enlargements. Only 31 of the boys use mosquito nets.

Examination of 16 pupils of the Malay Technical School is shown in Table 3. All the boys sleep in the school and do not use mosquito nets. The non-use of mosquito nets in so large a number of cases seems to indicate that mosquitoes are not plentiful and not infected where they do exist.

The other side of the Malacca picture is not so pleasant. Dr. CROUCHER had collected for me in the hospital twelve or fourteen fever cases to whom no quinine had been administered. I examined five cases with the following result:—

Case No. 1.—A Chinaman with the history of several attacks of fever. Had lived for past 3 years in Jasin, 21 miles out from Malacca town. During the six days previous to my visit he had rises of temperature every forty-eight hours or so. His blood twelve hours after last attack (Temp. 97.1) contained numerous crescents, much free and endo-leucocytic pigment and a large number of young actively amœboid forms. Rings and discoids a fifth or sixth the size of the red cells were common. None showed pigment. Twenty-four hours later the parasites had grown considerably, had developed almost quiescent pigment in the peripheral layers; the infected cells were in not a few instances brassy and shrunken. Crescents were numerous. Ten hours later the patient had another rise of temperature. Here was a case of Malignant Tertian.

Case No. 2.—*Chinaman.* Four years in Jasin. Several attacks of fever in past four years. Several rises of temperature since admittance occurring every 72 hours or so. Last rise at 4 p.m. on June 26th.

28th June, 1901. *Temp.* 99 *at* 11.15 *a.m.*—Many actively amœboid forms seen with a slight amount of pigment. The outline of the parasites is distinct. The pigment is coarse and deep brown in colour; movement of it is fairly active. No crescents to be seen.

29th June, 1901. *Temp.* 98 *at* 10 *a.m.*—Parasites distinctly larger, filling four-fifths of hosts. Latter not decolorised or enlarged. Outline of parasites distinct. Pigment plentiful in coarse dark brown rods and granules.

Amœboid movement has practically ceased. Three parasites seen completely filling hosts and having their pigment distributed in radial striæ.

5 *p.m.* *Temp.* 101.—Many mature forms with centrally clumped pigment showing lines of cleavage into rosettes of 8 or 9 nascent spores. I saw three of these break down, two into eight and one into nine spores having highly refractile nuclei. A case of Quartan.

Case No. 3.—Portuguese dresser from Muar in Johore (Map D. 6), 30 miles from Malacca town. He has been having almost constant fever for the past two months. Is anæmic and pinched in appearance.

27th June, 1901. 4 *p.m.* *Temp.* 100.1 *and rising.*—Many crescents and other forms of the crescent series present. Half-an-hour after the blood was drawn a flagellate body was detected. Both Benign and Malignant parasites are present. The former are mostly mature in red cells decolorised and enlarged. Three were observed with pigment centralised and having faint lines of division. It appears as though eighteen or nineteen spores would be produced. Several extra-corpuscular bodies with fine active pigment lay close to the debris of their recent hosts. A few early rings and discoids of the Malignant Tertian are observable, but larger forms of this type of parasite are more plentiful. The latter are about one-third the size of their red hosts and have developed a few fine peripherally situated granules which slightly oscillate. Several red hosts are shrunken and brassy looking.

A case of mixed infection by the Benign and Malignant Tertian parasite. The presence of the small rings and discoids in addition to the half developed larger Malignant Tertian forms would appear to indicate that there are two groups of this parasite present.

Case No. 4.—A Tamil from Machap, about 18 miles from Malacca town. History of rigor every fourth day. Last rise 25th June, 1901, at 9 a.m.

28th June, 1901. *Temperature* 99.4 *rising.*—Patient shivering. Many mature Quartan parasites. Several showing pigment centrally massed or arranged in two or three radial striæ, with faint indications of eight or nine lines of division. Three of these were observed to break down into eight nucleated spores each. A case of Quartan.

Case No. 5.—A Chinaman from Jasin three months ago. Had fever there several times. Has been living in a Chinese temple on outskirts of Malacca town for past three months. Last rise of temperature 25th June, 1901, 11 a.m.

25th June, 1901, 10 *a.m.* *Temp.* 99.4 *rising.*—Red cells frequently harbour Quartan parasites about mature.

It is probable that this man brought the parasites with him from Jasin,

In Jasin Hospital I find that the average admittance for intermittent fever is three per month. Death-rate nil. These cases are probably Quartan. About one remittent case is admitted per month. One death since January, 1901. These cases are probably Malignant Tertian, as will be seen from the following only case present on my visit.

Case No. 6.—A Chinaman. Estate coolie. Admitted 25th May, 1901, with remittent fever. Very cachexic. Fever immediately subsided on the exhibition of the quinine. As I entered the patient was in the cold stage of the only attack he had had since 25th May, 1901.

28*th June*, 1901. *Temp.* 103.6.—Blood at 1.30 p.m. contains many crescents, but I cannot detect fever forms of the Malignant type. There is an average of three sporulating Quartans to a field, however. I saw one break down into eight spores.

This case needs no comment except to point out that in its types of parasites it is similar to Cases 1, 2 and 5 seen in Malacca town and sent in from Jasin.

It would seem that the Quartan infection had been got since the patient's arrival in hospital. A remittent on admittance reacting promptly to quinine and a month later suddenly developing typical Quartan fever looks suspicious at least. The apothecary in charge says that often his ulcer cases develope typical intermittent fever that promptly reacts to quinine. These patients wander pretty freely about the jungle in the neighbourhood of the hospital.

There is sufficient here to show that Malacca town is practically free of Malarial fever, but that the province is the seat of three distinct types, *viz.*:—Malignant Tertian, and Benign Tertian and Benign Quartan.

A further search might have led to the discovery of a fourth type not uncommon in the other parts of the Peninsula, the Pigmented Quotidian.

Observation No. 9.

Penang (Map B. 2) or, more properly Georgetown, has a good fever record. So far as I could learn, but few Europeans contract Malaria in Georgetown itself. Dr. FREER says in his report (1900, page 30) that only three Europeans died of remittent fever and that of the 199 Sikhs admitted 92 were for Malaria. The Sikhs were men who had recently done duty in the Dindings or Pulau Jerejak. The former place is discussed under Observation No. 5 and the latter under Observation No. 11.

Dr. FREER further writes (1900, page 31) that in Malarial fever cases the microscopical search for the parasite has generally proved disappointing. Some good examples of pigmented parasites have been found in one or two bad cases from Deli (in Sumatra), but in cases of fever patients from Penang and even the Dindings the parasites found have nearly always been of the unpigmented kind.

From what I could learn in my short visit to Penang, I think it safe to say that but few Malignant cases originate in Georgetown. But Anopheles are to be found in Georgetown and its neighbourhood. In a pool of green scummed water at the foot of Penang hill and near the Botanical Gardens I found several larvæ of A. superpictus.

Malarial fever occurs amongst the Tamils who work the quarry. I could not find any aerial forms of Anopheles, but the presence of larvæ is suggestive.

At all levels of Penang hill I found Culex in abundance, and in water-buts near the summit larvæ in plenty.

One find was instructive. The surface of three rain tubs were thick with Culex larvæ. A fourth at another corner of the house was entirely free, being covered by a thin film of oil that had leaked from a paint pot leaning on its edge and against the house. Accidental protection of the surface of the water by oil had occurred.

As in Singapore (Obs. 13) so in Penang. The greater number of those admitted to the various hospitals for Malarial fever are lower class Orientals who contract it in such well known fever foci as Deli in Sumatra.

There were no cases in the General Hospital on my visit in December, 1900, so that I cannot tell from experience what the types of parasites are. But Dr. FREER very kindly went over his preparations with me. Most of his cases were Malignant Tertian, and come from the Dindings.

To Dr. FREER I owe my knowledge of a quick and sure method of permanently preparing Anopheles for microscopical examination.

A drop of Canada balsam is placed on a slide, a recently killed Anopheles is taken up gently and placed limbs downward in the balsam. It immediately spreads out so that wings and limbs can be readily examined at once or when the balsam hardens.

Observation No. 10.

Province Wellesley (Map B. 3) is a large flat territory, thirty miles long and from eight to twelve miles wide. Here and there a small rounded granite hill springs from the plain. But the province is mostly dead level and only slightly above the ocean till it reaches a moderately high range of hills in the background, about eight miles from the sea. It is all under sugar cane and paddy cultivation. The paddy fields are wet and the sugar grounds are frequently intersected with shallow canals of sluggish water, never more than twenty feet wide. The canals are used to convey the cane to various mills. They are ideal mosquito breeding-grounds.

Butterworth is the centre of administration and here is located the chief provincial hospital in charge of Dr. Dane (on my visit in December, 1900).

Dr. Dane, anticipating my arrival, had found for me two large iron tanks in the hospital grounds, one covered by a chance film of oil and so free of mosquito larvæ, while the other, not two feet distant, contained a dozen or more of the species Anopheles and several rafts of eggs. From the eggs and larvæ Anopheles superpictus was afterward raised. The presence of larvæ here was only one of several instances in the neighbourhood. Yet an original case of fever is scarcely known in this part and no cases develope amongst surgical and other patients.

The hospital records show that there has been but little fever for some time past in Province Wellesley. There were no cases in hospital.

The large Prye River Sugar Estate was visited. Several hundreds of coolies are employed upon it, but fever is rare amongst them. I found but few Anopheles' though multitudes of Culex larvæ in the neighbourhood of the works. In the canals along the roads and in puddles in the paddy-fields Anopheles' larvæ were sometimes found in quantity. This is another instance where the presence of Anopheles is not necessarily accompanied by fever, and that to render the Anopheles of moment they must be first infected by man.

Observation No. II.

The Island of Jereja (Map B. 3) is used by the Penang authorities as a quarantine and isolation station for lepers. Accompanied by Dr. DANE I found in the brackish clear pools formed by rain and spray in depressions of the rocks along the shore, many Anopheles' larvæ and a few rafts of eggs. In a large quantity of muddy filthy drainage water from the leper hospital I also found about forty Anopheles' larvæ. Finding larvæ in such places illustrates what is a common observation in this part of the world that Anopheles' larvæ are to be found in all sorts of water. Eggs are probably deposited in swiftly running water even ; larvæ are not seen in it because they are carried away or destroyed by fish.

On a somewhat higher level and one hundred yards behind the hospital and dressers' quarters is a small reservoir fed by a hill spring. In it I found hundreds of rafts of Anopheles' eggs, but only a few Anopheles' larvæ. There were no Culex larvæ present. That there was an abundance of eggs present and a few only of the larval form of Anopheles was due I think to the presence of several hundred small fish. That the eggs were of Anopheles was proved by their subsequent development.

On this island is a large hospital for lepers. At present there are several hundred isolated. Occasionally, I was informed by Dr. DANE, the lepers develope Malarial fever of a type that quickly reacts to quinine. No charts had been kept and there were no fever cases in hospital on my visit.

Amongst the Tamil dressers fever of a Malignant type is more common and they are often invalided to Penang. No cases on my visit.

Considering the presence of Anopheles in the neighbourhood of their quarters and the state of the reservoir from which they draw their drinking water, it is not surprising that the dressers contract the fever.

Observation No. 12.

This was made along the trunk road from Kwala Kubu (Map C. 4) to Kwala Lipis (Map D. 3); the neighbourhood of Kwala Lipis and the various centres of Malay population on the river between Kwala Lipis and Pekan (Map E. 4).

In Kwala Kubu hospital I found a record of about twelve cases of Malarial fever per month. Most of these cases occur amongst the Chinese miners along the railway line south of Kwala Kubu, Tamil coolies of the Public Works Department and Police Constables. The charts indicate Pernicious, Benign Tertian and Quartan fever. There was but one case in hospital on my visit. No rise for several days. Patient had been liberally dosed with quinine. He was a Police Constable from Sanka Dua (Map C. 4), twelve miles out towards Pahang on the main road.

Sanka Dua Police Station (Map C. 4) visited on the 22nd July, 1901. It is situated on a bluff at the junction of two rapidly running streams that flow over and are fed by other streams flowing over disintegrating granite. The station is 60 feet above the streams. At the junction of the latter is an exposed angle of rough and deeply indented red granite about 60 square feet in extent. In the pools formed in these depressions I found numerous larvæ of A. superpictus. Several aerial forms were afterwards found in the barracks. The inmates of the latter are not provided with mosquito nets. Every inmate of the barracks gave a history of recent fever that had reacted to quinine. Several constables had had fever before coming to this post.

The following is an illustrative case:—A. K., Police Constable, No. 473, age 20. Lived in India for 18 years. Never had fever. Two years ago came to Kwala Lumpur and lived with his friends for 18 months. No fever. Fifteen months ago joined the Police Force and was stationed at High Street Station, Kwala Lumpur. No fever. Four months ago was transferred to Sanka Dua. Sixteen days after arrival he developed a bad attack of fever. Was treated at Kwala Kubu Hospital and discharged as cured. Had a second attack three months and a third two months ago. Cured at Kwala Kubu Hospital.

This morning at 4 o'clock a fourth attack began, first with shivering, then great heat and now (9 a.m.) severe sweating. Temp. 99.6. A few Quartan parasites with radial pigment present. One observed with lines of cleavage into eight spores, pigment massed centrally. These were probably all laggards of the group that had just maturated.

This case well illustrates the fact that Malarial fever will develope alongside water running over red granite on condition that (*a*) the water provides a good breeding-place for Anopheles, (*b*) the aerial forms of the latter become infected, and (*c*) mosquito nets are not used.

The few Tamils and Malays living near this station continually suffer from fever. The place is closely beset by jungle. There is no reason why it should not be made Malaria free. Mosquito nets ought to be provided.

From Sanka Dua to Semankoh Pass (about 2,700 feet above sea level) the main road gradually ascends the great volcanically-formed backbone range of the Peninsula. The road is closely beset by jungle on both sides. Shady pools are numerous and occasionally a clear running stream is met with. Drink such water, I have been told by the holders of the red granite theory of the causation of Malaria, and you will contract fever.

In many of the pools as high as 2,300 feet I found Anopheles' larvæ. I found them several times in the neighbourhood of the above mentioned running water. It is instructive to note that at these running streams numberless bullock carts have halted for the night for their Tamil, Bengali, Malay and Chinese drivers to eat and sleep.

The drivers sleep in the open air wholly unprotected by nets. I failed to find any aerial forms of Anopheles about, a difficult thing always in the jungle. But the presence of their larvæ is proof enough of their presence. This with infected coolies passing one way or another, and sleeping by hundreds at regular halting-places by running streams will explain the fever occasionally contracted by Europeans along this line of travel. I have always found Anopheles and the presence of infected coolies in those foci where Malarial fever is supposed to be due to disturbance of red granite and to the drinking of water that runs over it.

At Tras (Map C. 4) on the Pahang side of the mountain range Malaria is a scourge. Tras is a halting-place, and the centre of a mining district. A few hundred Chinese, a small number of Malays, Tamil and Bengali carters are always present. A Police Station is here and gave me information as to the type of fever present and its close association with Anopheles.

Seelemmoh, aged 2, Malay girl, daughter of the Sergeant-Major. A very sick looking child. Spleen greatly enlarged. Has had fever almost continually for four months.

10 *a.m.*, 22*nd July*, 1901.—Blood shewed many small active plasmodia, ringlets, and discoids, of various sizes and degrees of pigmentation. Brassy bodies common. Also crescents. A case of Malignant Tertian.

A Bengali mine watchman from the neighbourhood proved to be a case of Quartan.

Within 20 yards of the Station I found 3 Anopheles' breeding-pools. The Police are badly bitten in the barracks at night. I found several aerial forms of A. superpictus and A species *a*; none of the latter infected.

Raub Hospital (Map D. 4) gave me 3 cases of Malignant Tertian, 1 of Benign Tertian and 2 of Quartan all from the neighbourhood.

I found several Anopheles' breeding-pools in various parts of the town, and three out of eighteen aerial forms containing blasts in their veneno-salivary glands.

Kwala Lipis (Map D. 3) is at the end of this main artery of travel and its hospital receives many cases of Malaria contracted by coolies along the roads leading to it, by police in barracks and on night patrol, and amongst the miners in the neighbourhood.

The town itself is fairly free of fever owing to the good work of the Acting Residency Surgeon, Dr. GIMLETTE, along all the lines by which Malarial fever may be combatted.

Of the twelve cases I found in the hospital,

5 were multiple Malignant Tertians.
2 ,, ,, Benign ,,
1 was single ,, ,,
3 were ,, Quartan
1 was multiple ,,

All these cases had resided in various parts of Pahang for from five to sixteen years and had had several attacks of Malarial fever. The present attacks had occurred outside Kwala Lipis. More than half of them gave a history of having been recently at Lobo Bleda, a landing-place about two-and-a-half miles down the river from Kwala Lipis.

Lobo Bleda is made up of a small Malay village, and temporary sheds of workmen and coolies in the employ of the Kechau Gold Mining Company, two miles inland. I found it a veritable hotbed of Malignant Tertian and Quartan fever. Infection spreads from it in all directions. I afterwards found boatmen, watchmen and others as far away as Kuantan (Map E. 3) and Singapore (Map E. 4) with Quartan fever contracted in this spot.

In the Malay Kampong I found 16 children ranging from 6 months to 12 years in age. A history of fever was determined in all. Fifteen of them had enlarged spleens, eleven enormously. Three of them when examined showed crescents but no fever forms. The adult Malays all gave a history

of fever. In boats moored to the bank I found 7 cases in various stages of fever. One proved to be a double Malignant Tertian. One a single Malignant Tertian and three multiple and two single Quartan.

I found several breeding-places of Anopheles superpictus, but could find only one aerial form; a male.

It is in foci such as Lobo Bleda that Europeans most readily contract fever, and from which fever spreads widely. Most of the loose population who contract fever remain untreated, and when exhausted move to some other focus, carrying infection with them. The first case I afterwards examined in Singapore proved to be a mine watchman who had contracted Quartan fever at Lobo Bleda about the time of my visit.

Such wanderers use no mosquito nets, sleep at well known halting places where running water is procurable and no doubt infect Anopheles in the vicinity. Others sleeping in the same place under like condition, and hitherto free of fever, contract it from the bite of the infected Anopheles and then attribute it to having drunk water that had run over disintegrating red granite.

Lobo Bleda, it will be noticed, contained a large percentage of children having a history and signs of fever.

All the Malay villages that I stopped at between Kwala Lipis and Kwala Pekan (Map E. 4) are more or less rife with at least three varieties of Malarial fever.

The children of any kampong are a sure index, I found, of the fever rate.

PULU TAWAR (*see* Map D. 4).

At this place I found no fever cases. The children examined would indicate that it is nearly free from Malaria fever.

No. Examined.	Average Age.	No. with signs and history of fever.	Percentage.
63	8	2	3.1

Temerloh (*see* Map D. 4) and its neighbourhood is only slightly infected. The blood of seven children who had had fever during the week previous to my visit (25th July, 1901), or who had fever when brought to me for examination contained parasites. Three Malignant Tertian, two Quartan and two Benign Tertian.

The following tables are of the Kampongs along the river edge, number of children examined, average age, etc., and the percentage with a history and signs of Malarial infection:—

TEMERLOH.

No. Examined.	Average Age.	No. with signs and history of Malaria.	Percentage.
39	7	22	56·4

KAMPONG LEBAK.

The total number of children in Kampong Lebak is about 80.

No. Examined.	Average Age.	No. with signs and history of Malaria.	Percentage.
30	6	7	23·3

KAMPONG TENGA.

Total number of children about 70.

No. Examined.	Average Age.	No. with signs and history of Malaria.	Percentage.
25	5—6	13	52

KAMPONG BUNTUT.

Total number of children about 100.

No. Examined.	Average Age.	No. with signs and history of Malaria.	Percentage.
57	6	23	40·3

About all these Kampongs I found larvæ of A. superpictus common, A. species *a*. rarely and a few larvæ of a large black species that I am not able to identify. Only a small percentage of the inhabitants of these Kampongs use mosquito nets. None of the children except the very youngest who sleep with parents who can afford nets.

No doubt this in part explains the abundant signs and history of fever amongst the children.

I found Pekan (Map E. 4) itself practically free of fever. The neighbouring Malay Kampongs are not badly infected. Mosquito nets are used more commonly, and I found but few Anopheles' breeding-places.

From the Pekan vernacular school I compiled the following table:—

No. Examined.	Average Age.	No. with signs and history of Malaria.	Percentage.
57	10	2	3·5

These boys attend from a wide radius. Most of them use mosquito curtains.

The undermentioned Kampongs were visited and the results tabulated:—

KAMPONG PLEEM MADALAM.

Total number of children about 50.

No. Examined.	Average Age.	No. with history and signs of Fever.	Percentage.
28	6	2	7·1

KAMPONG HADJI.

Total number of children about 18.

No. Examined.	Average Age.	No. with signs and history of Malaria.	Percentage.
16	5	4	25

KAMPONG DALAM.

Total number of children about 40.

No. Examined.	Average Age.	No. with signs and history of Malaria.	Percentage.
25	8	3	12

These tables tend to show that Pekan and neighbourhood is less fever ridden than the Malay centres farther up the river.

The blood of several children contained crescents and I found one Quartan case on the point of sporulation.

Observation No. 13.

Singapore (Map E. 6). Visited in August 2—11, 1901.

To Drs. MUGLISTON (the Acting Colonial Surgeon), LEASK, DANE, MIDDLETON and Captain ROBINSON, R.A.M.C., I owe many thanks for trouble taken to make my visit successful.

The general opinion of the Local Medical Staff seemed to be that Europeans rarely contract Malarial fever within Singapore town. Malaria in a European is easily proved to have been contracted in some well known focus in Singapore island, or Johore.

I saw only one European case in the General Hospital, a gentleman who had just arrived from, and had contracted fever in Bangkok. Some such history is usual in the cases of every European who applies for treatment for Malarial fever.

This note is in accord with what I struck in Penang, Kwala Lumpor and other centres of European population. The reason is not far to seek. The conditions that combine to produce Malarial fever are absent in the greater part of European and enlightened Oriental Singapore.

In one place in Singapore Malarial fever is endemic, *i.e.*, Tanglin Barracks.

The Tanglin Barracks, lately occupied by the 16th Madras Infantry, is rife with several types of Malarial fever. Capt. ROBINSON, who accompanied me on my visit, has never failed to find larvæ and aerial forms of A. superpictus in or about some part of the barracks, and I myself found larvæ plentiful in May, 1900, along the edges of a small lake just below the barracks.

None of the inmates use mosquito nets: a neglect which is incomprehensible except on the supposition that it is more economical for a large percentage of the garrison to be sick of fever than to be provided with mosquito nets.

With Captain ROBINSON I examined about fourteen men who had had fever. They were all, except one, feverless at the time of examination, having been carefully dosed with quinine. The blood of a few of the men exhibited crescents but no other direct signs of Malaria.

One man, however, had a temperature of 102.3 and complained of fever. I found many almost mature Benign Tertian parasites in his blood. It is probable that this or the Quartan is the prevailing type in view of the absence of signs of Malignancy in most of those examined.

Fifteen or twenty of the men are regularly off duty as the result of Malarial fever. Destruction of Anopheles' breeding-places, the use of mosquito bars and the proper exhibition of qûinine would undoubtedly soon render the barracks Malaria free.

Dr. LEASK kindly placed the following General Hospital cases at my disposal for study.

August 2, 1901. *Case* 1.—This case well illustrates the manner in which Malarial infection is transported.

M. S., Bengali, aged 25. Arrived in Pahang nine months ago direct from India and began work as a watchman at the Kechau Gold Mines near Lobo Bleda. (*See* Obs. 12.)

It will be remembered that at the latter place Quartan fever is rife. He was perfectly well during his whole stay of nearly nine months at Kechau. Slept at Lobo Bleda ten days ago and was so badly bitten by mosquitoes that he could scarcely sleep. Came down the Pahang river and East Coast of the Peninsula and arrived in Singapore four days ago. Felt well till last night about 6 p.m. when he got very cold, then hot, but perspired freely about 2 a.m. this morning.

Blood at 4 p.m. showed a large number of Quartans about ¼ the size of hosts This case, further observed, proved to be a single infection by the Quartan parasite seemingly contracted at Lobo Bleda, a notorious Quartan focus, near Kwala Lipis. In such manner is the parasite of Malaria introduced and in the presence of Anopheles becomes the centre of Malarial radiation.

Four other cases examined proved to be: one Benign Tertian, one Quartan and two Malignant Tertian, all contracted outside Singapore town.

Amongst Dr. DANE's cases in the Pauper Hospital I observed Malignant Tertian, Benign Tertian and Quartan all contracted in the native quarters or just outside the city limits.

The neighbourhood of Singapore is thus affected by at least three types of Malarial parasites.

To Dr. MIDDLETON, Health Officer, I am indebted for one of the most convincing pieces of evidence that the disturbance of soil is not *per se* the cause of Malarial fever, but that in all instances where fever does break out under such circumstances it is due:—

1st, to the introduction of the Malarial parasites in the blood of coolies newly on the scene;

2nd, to the presence of Anopheles which become infected;

3rd, to the non-protection of healthy coolies who are in the neighbourhood of those infected. A vicious circle is thus established.

Dr. MIDDLETON has furnished a history of this outbreak under Observation 14. I visited the spot with him and Dr. LEASK on August 5, 1901, and my own observations fully confirm his.

In a new quarters on one of the hill sides lately provided for the Bengalies I found several men suffering from fever. A few others on returning from work complained that they were about to have another attack.

Seven cases in all were examined and five proved to be Quartans. The other two negative. All these men gave a history of having had fever in Assam.

In the quarters I found several aerial forms of A. superpictus, and one A. species *b*. containing zygotes.

An inspection of sheds *a* and *b* (*see* Obs. 14) convinced me of the readiness with which infected Bengalies minus protection by net, plus Anopheles could infect the unprotected Javanese in the same sheds.

The Bengalies have now been isolated, Anopheles' breeding-pools have been filled and quinine is being administered. The number of fever cases is in consequence decreasing in spite of the fact that the work of excavation continues.

This observation is strictly in accord with what I found at Jugra (Obs. No. 1) and at all other places where Malarial fever is attributed to the disturbances of soil or drinking of water that has run over laterite.

Dr. MIDDLETON writes me under date August 31, 1901: "Since your "visit the coolies have been treated with Quinine at the times and with "doses you recommended. There are, I believe, three men in Hospital "from other diseases, but not a man down with fever. The work at "excavating goes on just the same."

ILLUSTRATIVE CASES.

Case No. I.

T., a Tamil. Age, about 40. In India he was employed as a farmer. Five months ago was brought to Selangor as an immigrant coolie and was sent to work on the railway extension at Kajang (Map C. 5). Worked steadily for about two months. Three months ago, about the 1st of November, he says he was exposed to a heavy shower. That evening he had severe headache and was sent into the Kajang Hospital. There he remained through November, December and January and, not improving, was sent into the District Hospital, Kwala Lumpur.

I saw patient on the morning of January 30th and found him greatly emaciated with slight œdema of both shins, conjunctival and mucus membranes pale, spleen moderately enlarged, and complaining of slight headache. There had been no vomiting or diarrhœa at any time. Says that he never feels cold, but very hot and wet sometimes. Altogether has little to complain about.

10 *a.m.*, *Temp.* 102.3.—I found many pigmented parasites, about three to a field. (Zeiss obj. Apochrom. 2.0 m. m. Comp. Eye Piece No. 6.) The infected red cells are enlarged and slightly decolorised. Most of the parasites are half the size of a red cell. Pigment grains are numerous, fine, and peripherally situated. It is obvious that the parasites are not all in the same stage of development. There are certainly two and perhaps three groups. A few extremely small, rounded, colourless, actively pseudopodic amœbulae are rarely seen. Sometimes they appear as rings, or irregular blunt and club pointed stars.

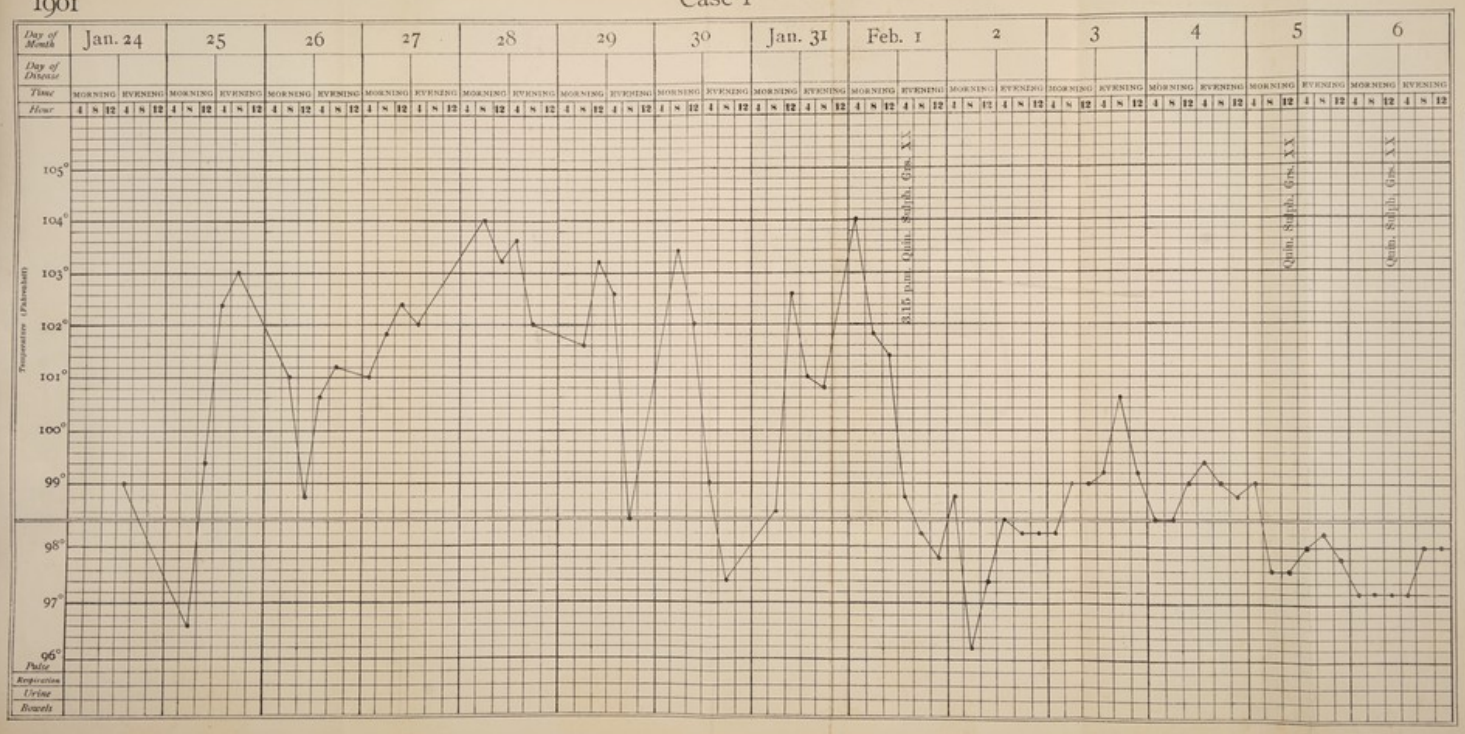
A larger number, about a quarter the size of an erythrocyte, are present. They contain fine actively swarming, peripherally situated, yellowish granules. The outlines of the body are faint and disappear and reappear under the eye.

A few extra-corpuscular forms, some globular, others lobulated, are to be seen. Their pigment swarms actively and is red-brown in colour. No flagellæ are observable.

12-30 *p.m.*, *Temp.* 100·4.—The smallest hyaline forms are rare. Those filling half the corpuscle are numerous. It is not seldom that one sees a parasite almost filling its enlarged host. In this specimen the pigment was still active at 3 p.m. But many more extra-corpuscular forms with active pigment were present. A few mononuclear pigmented leucocytes are seen in each field. No flagellate bodies observed.

1901

Case 1


Day of Month
Jan. 24
25
26
27
28
29
30
Jan. 31
Feb. 1
2
3
4
5
6
Day of Disease
Time
MORNING
EVENING
Hour
4 8 12
Temperature (Fahrenheit)
105°
104°
103°
102°
101°
100°
99°
98°
97°
96°
Pulse
Respiration
Urine
Bowels
Quin. Sulph. Grs. XV
Quin. Sulph. Grs. XX
Quin. Sulph. Grs. XX
Temperature (Centigrade)
42°
41°
40°
39°
38°
37°
36°
35°

3-15 *p.m.* *Temp.* 99·3.—Numerous mononuclear pigment containing leucocytes present. Parasites not so numerous. Most of them are half the size of a red cell. Many of the smallest sized amœbullæ are present. A few only of the largest size to be observed. No sporulating parasites and no flagellate bodies present. Many extra-corpuscular bodies present, some round, some lobulated, a few broken up into threes and fours. All of these have actively swarming pigment. A few large, irregular, quiescent extra-cellular forms present.

January 31, 1901.—Spleen is somewhat larger. Patient does not complain even when there is marked pyrexia. His appetite is poor. Blood taken yesterday at 12-30 p.m., still alive. Parasites still active, and in most of them the pigment swarms rapidly. In a few the granules are quiescent and more compact and centrally situated. But I could not, after prolonged observation, detect signs of striation and formation of spores. I observed many large forms as they escaped from their hosts, but saw no flagellate bodies.

10-15 *a.m.*, *January* 31, 1901. *Temp.* 100.—Numerous, very active, unpigmented, small sized amœbullæ in the peripheral aspect of the red cells. Changes in shape due to the thrustings of pseudopods are rapid and marked. In addition to these hyaline forms are a not rare number of median sized slightly pigmented forms, and every field contains one or more large full-grown pigmented parasite. The cells containing the latter are noticeably enlarged and decolorised. Rarely one meets with pigmented mononuclear leucocytes. So far I have not observed phagocytosis. A blood count by means of the Thoma-Zeis apparatus this afternoon gave 1,500,000 red cells, Hæmoglobin 40%. The red cells are markedly irregular in size, and extremely pale.

February 2, 1901, 10-30 *a.m.* *Temp.* 101·3.—Numerous almost mature parasites. Pigment active. In several corpuscles it is not unusual to see 3 or 4 distinct foci of pigment very active but never intermingling. On close examination these foci prove to be large rounded pseudopods.

For the first time I observed a flagellate body. A large parasite whose host was just visible as a slight almost colourless ring, was seen to burst out into the liquor sanguinis. In about ten minutes after the escape the pigment grew more noticeably active and the edge of the body rapidly undulated. Delicate, colourless, actively motile flagellæ suddenly burst out from three points of the periphery and violently lashed about. The pigment swarmed rapidly and became slightly more centralised, but soon the parent body appeared to fragment, the flagellæ broke loose and rushed about for some time. Finally I lost sight of them after cessation of motion.

2 *p.m.*, *Temp.* 100.—A large number of the smallest hyaline forms present; also a moderate number of median and large sized forms. Pigmented leucocytes are abundant. This specimen was watched in a Pfeifer's warm chamber for some time, and I was rewarded by seeing in

two instances the lines of cleavage occur, the centralisation of the pigment and the irregular segmentation of the parasite as known to occur in the Benign Tertian plasmodia.

3-30 *p.m., grs.* xx *Quinine Sulph. was given.* 4 *p.m.*—Organisms of all sizes still active, pigment swarms but slowly, the pseudopods of the median sized parasites are rounded rather than pointed. There appears to be an increase in the number of extra-cellular forms, and under the eye they soon break up and become quiescent. The whole number of parasites is less than at 2 p.m.

February 2, 1901, 9-30 *a.m., Temp.* 97.—Many pigmented leucocytes in the peripheral blood. After a prolonged search of many specimens, I saw one dropsical, broken up extra-cellular form but not a single parasite of any other description.

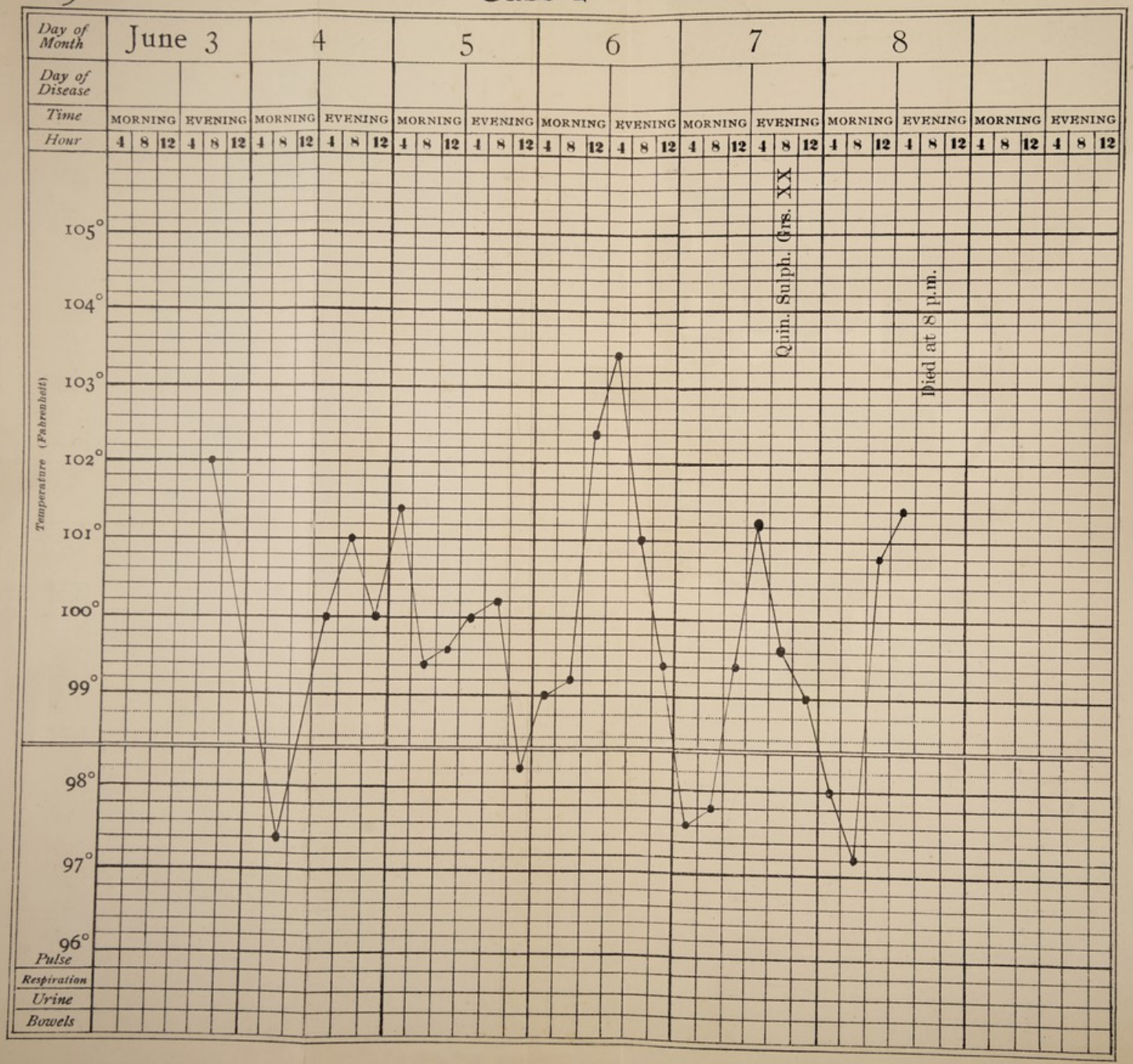
February 3, 1901, 9 *a.m., Temp.* 99.—A few pigmented leucocytes. No parasitic forms whatever.

February 5, 1901, 9 *a.m., Temp.* 98.—No parasitic forms. No pigmented leucocytes.

I have not seen a case of Benign Tertian in which the peripheral blood was so burdened with parasites as this. It is really remarkable that one dose of 20 grs. of quinine should have so far destroyed them that none were seen again, and that no rise of temperature occurred while the patient was in hospital. (*See* Chart 1.)

1901

Case 2


Day of Month
June 3
4
5
6
7
8
Day of Disease
Time
MORNING
EVENING
Hour
4 8 12 4 8 12
Temperature (Fahrenheit)
105°
104°
103°
102°
101°
100°
99°
98°
97°
96°
Pulse
Respiration
Urine
Bowels
Quin. Sulph. Grs. XX
Died at 8 p.m.
Temperature (Centigrade)
42°
41°
40°
39°
38°
37°
36°
35°

Case No. 2.

Malarial Case No. 2.—*A. K., Bengali. Age* 35. Admitted to District Hospital, Kwala Lumpor, June 3. 1901. Died June 8, 1901.

For the three months before admission patient had been working as a wood-cutter near Ampang. Fifteen days ago (May 18, 1901) a first attack of fever occurred followed every third day for a week by a similar attack. Just before admittance the attacks became more frequent and he was cold and hot nearly every day.

June 5, 1901.—Complains of pain all over body. No appetite. Vomited twice yesterday. Is restless but dull mentally. Spleen greatly enlarged.

12-30 *p.m., Temp.* 99.4.—A few small, slightly active amœboid parasites a sixth to a quarter the size of red hosts. Parasites clear, well defined and refractive. From four to six grains of lively oscillating pigment in peripheral layers. Red hosts not enlarged or decolorised ; a few, however, are shrunken, spiculated and brassy looking.

June 6, 1901, 10-15 *a.m., Temp.* 101.—Numerous annular and discoid parasites a tenth the size of hosts, quite unpigmented and quiescent. Also many lively amœboid plasmodia that rapidly alter in shape, some taking on a signet-ring form and quickly an irregular amœboid form again. When these become annular all movement ceases, the dark centre gradually grows smaller and seems to disappear as though digested.

Another group about double the size of the above is present. The characteristic ringlets and discoids have developed a few fine peripherally situated pigment granules, oscillating slightly. The number of both groups of parasites is enormous, about three to a field (Zeiss comp. oc. no. 6. apo. obj. 2.5 mm.) and there are many doubly infected cells. The latter are always infected by members of the same group. Pigmented leucocytes and free pigment are often seen. Many crescents present.

12-30 *p.m., Temp.* 102.3, *same as above.*—In addition, one almost mature form observed. Crescents numerous.

June 7, 1901, 8 *a.m., Temp.* 97.4.—Many crescents, two of which later on developed into flagellate bodies. A few scantily pigmented quiescent forms observed in brassy looking slightly shrivelled hosts. No mature forms seen. Many of the earliest ring and discoid forms present, not rarely two in a host.

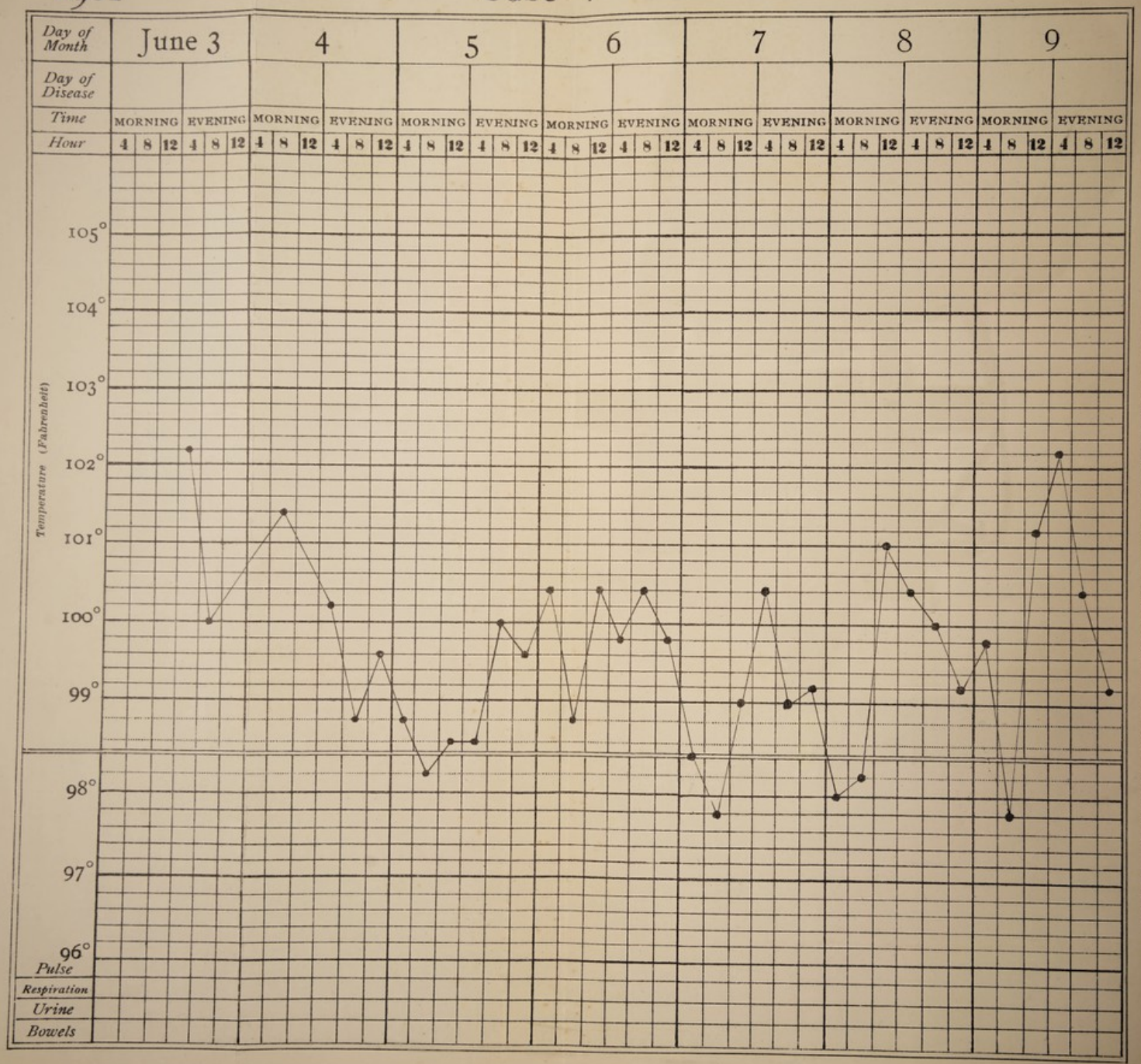
4 *p.m.*—Several parasites observed about a third to a half the size of red hosts, outlines clear, organisms slightly amœboid, pigment centrally or excentrically clumped. Rings and discoids of this morning have grown slightly. A few show one or two fine oscillating pigment granules in periphery.

Patient complains of pain and fever all over body.

June 6, 1901, 2 *p.m.*, *Temp.* 101.2.—Crescents and other crescentic bodies numerous. Several doubly and trebly infected cells. Numerous ring-shaped and discoid plasmodia containing from four to five oscillating pigment granules in periphery. Infected cells occasionally shrunken and brassy coloured. Patient died suddenly while comatose at 4 p.m. to-day (June 8, 1901). Spleen and brain crowded with malignant tertian forms in three different stages of development.

1901

Case 4


Day of Month
June 3
4
5
6
7
8
9
Day of Disease
Time
MORNING
EVENING
Hour
4 8 12 4 8 12
105°
104°
103°
102°
101°
100°
99°
98°
97°
96°
Temperature (Fahrenheit)
42°
41°
40°
39°
38°
37°
36°
35°
Temperatur (Centigrade)
Pulse
Respiration
Urine
Bowels

Case No. 4.

Malarial Case No. 4.—*N. C., Chinaman. Age* 32. Mining Coolie. Admitted to District Hospital, June 3, 1901. Discharged June 17, 1901. Patient has been working at Klang for the past two years. Had no fever till May 29, 1901. Says that he had cold, hot and wet fever every second day for a week, then the fever came oftener.

June 3, 1901.—Has swelling of both feet, and headache. Appetite good. Spleen slightly enlarged.

June 6, 1901.—Still has oedema of feet, is anæmic looking. Had a rigor to-day.

June 8, 1901.—Still has headache. Rigor to-day.

June 9, 1901.—Says he feels better. Rigor to-day.

June 10, 1901, 10 *a.m., Temperature* 99.4, *rising*.—Rigor beginning. Numerous median sized discoids and rings in red cells. Many cells doubly infected. These show one or two fine grains of oscillating peripheral pigment.

A few smallest size actively amœboid plasmodia that occasionally form rings, remain quiescent for awhile and then resume their activity.

An occasional plasmodia about half the size of its host. Pigment densely massed centrally or slightly excentrically. Hosts brassy looking and in several instances are retracted and shrivelled. Pigment and plasmodia exhibit a slight movement. Crescents are numerous. During examination some of them were observed to sluggishly become cigar shaped and even ovoid. One flagellated body observed at 10-53 a.m.

There is a slight amount of free pigment. Leucocytes are extremely active. One was seen to ingest an ovoid. A few only are pigmented at 4 p.m. Temperature 100.1, falling. Grs. 20 quinine sulph. was given.

June 11, 1901, 3-20 *p.m., Temp.* 97.5.—Numerous members of crescentic series present. No fever forms. A scant amount of free and endo-leucocytic pigment present.

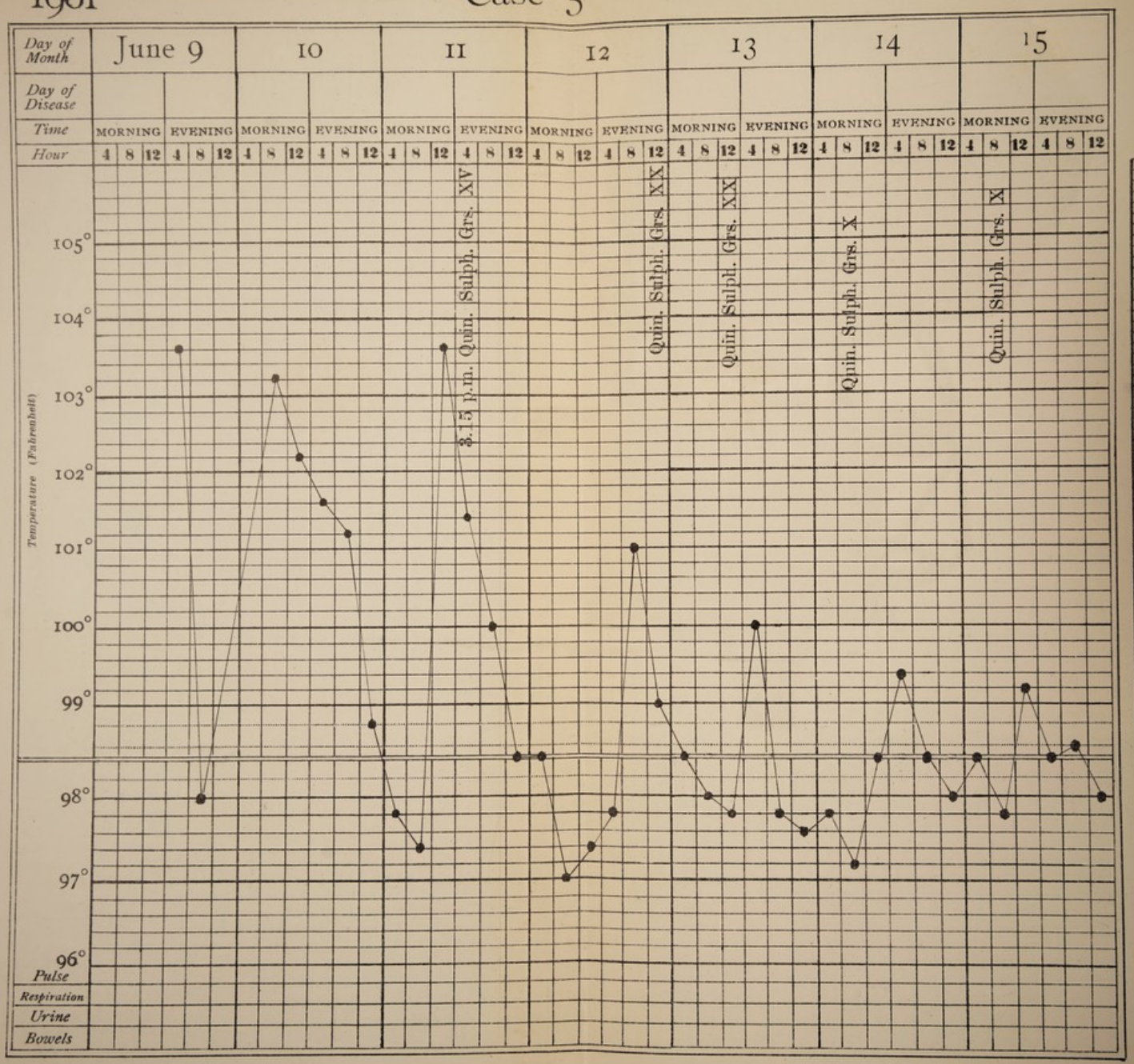
June 14, 1901, 11 *a.m., Temp.* 97.4.—Many crescent, fusiform and oval bodies present. Several almost mature Malignant Tertian forms also.

A second generation of half mature parasites present. Many cells doubly infected in their margins exactly resembling the syzygies of Manneberg. One flagellate body seen. 12 noon grs. 20 quinine sulph. administered.

This man showed no more fever forms nor had he another rigor up to the time of his discharge on June 17, 1901. Crescents, however, and other members of the crescent series had persisted numerously. When I first examined him on June 10, 1901, he had three distinct generations of Malignant Tertians in his blood. Two 20 grs. doses of quinine were effective against the fever forms.

1901

Case 5


Day of Month
June 9
10
11
12
13
14
15
Day of Disease
Time
MORNING
EVENING
Hour
4 8 12 4 8 12
105°
104°
103°
102°
101°
100°
99°
98°
97°
96°
Temperature (Fahrenheit)
42°
41°
40°
39°
38°
37°
36°
35°
(Temperature) (Centigrade)
3.15 p.m. Quin. Sulph. Grs. XV
Quin. Sulph. Grs. XX
Quin. Sulph. Grs. XX
Quin. Sulph. Grs. X
Quin. Sulph. Grs. X
Pulse
Respiration
Urine
Bowels

Case No 5.

Malarial Case No. 5.—*N. K., Chinaman. Age* 29. Admitted to District Hospital June 9, 1901. Discharged July 1st, 1901.

Complains of fever coming every day at 4 p.m., leaving at 6 p.m. Temp. on admittance, 103.4. Spleen tender but not noticeably enlarged. Patient dull and weak.

For the past year he has been working as a mining coolie at Sungei Besi near Kwala Lumpor. He was very well till the 15th May when he had some chilly sensations, then felt extremely hot, but was well again by 9 p.m. He felt this way several times every second day but lately every day.

June 10, 1901.—Had a rigor beginning at 10 a.m. Blood at 11-30 a.m. contained many crescents, abundant free pigment and pigmented leucocytes. Many rings and discoids present with from 1—5 fine pigment grains oscillating in the peripheral layers. The plasmodia exhibit slight amœboid movement. Several almost mature parasites seen about one-half the size of hosts. The plasmodia are excentrically situated in the red cells with their pigment massed generally on the edge.

June 11, 1901, 10-30 *a.m.*—Patient looks worn, with coma threatening. Blood contains an enormous number of small actively amœboid plasmodia that form quiescent ringlets in some cases and then break again into active plasmodia.

Every second or third field contains discoids and ringlets with a few fine pigment grains in the peripheral layers that rapidly oscillate. There are many brassy bodies containing generally a ringlet with a few pigment granules. A few of these bodies are markedly shrivelled and spiculated.

A few almost mature parasites such as seen yesterday are now observable. This makes the third distinct group in the blood.

Many crescents present which in the course of half-an-hour's observation became ovoid, cigar-shaped and globular. By Manson's moist cell method I was able to develope seven flagellate bodies in 12 slides. Grs. 15 quinine sulph. was given at 3 p.m.

June 12, 1901.—Patient very weak and comatose. Spleen enlarged slightly. Cannot answer questions. Blood at 11-50 a.m., Temp. 97.4, contains numerous large ringlets and discoids slowly amœboid, with a few fine peripheral rapidly oscillating pigment grains. Many red cells with peripherally-situated almost mature parasites. Free pigment abundant, also pigmented leucocytes.

2 *p.m.*—Temp. 99 falling. Grs. 20 quinine sulph. given.

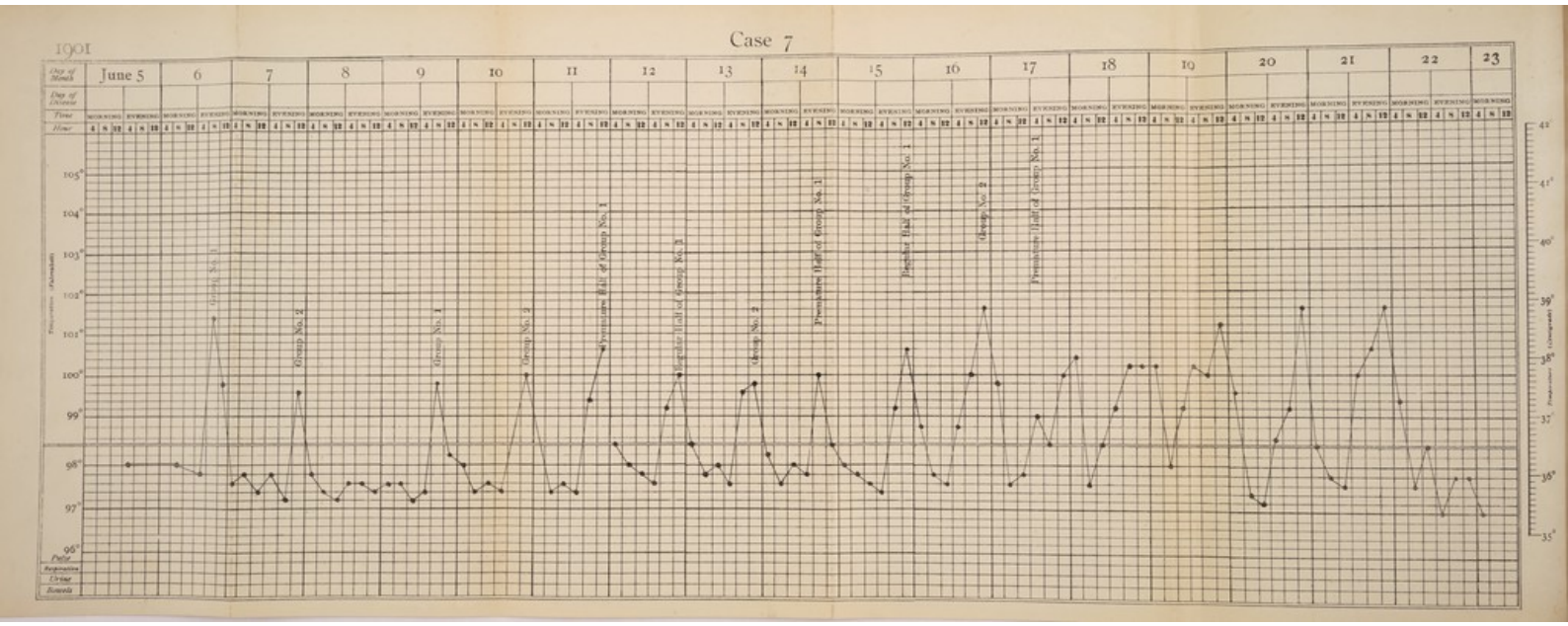
June 13, 1901, 11 *a.m.*, *Temp.* 97.4.—Patient moans, is very dull. He hiccoughed steadily from 7-50 to 8-05 a.m. Two distinct generations of Malignant Tertian parasites still present. One, a fifth the size of hosts, containing a few fine pigment grains rapidly oscillating in the periphery, the second of a few almost mature parasites.

Many crescents present, also free pigment, brassy and shrivelled infected cells. 12 noon grs. 20 quinine sulph.

I did not see this case again till June 19, 1901. He had slight daily rises on June 14 to 18, 1901, in spite of grains 10 quinine sulph. daily. At 10 a.m. on June 19, 1901, I could find no fever forms. Crescents were plentiful. No pigment to be seen. Patient had improved from a comatose to a cheerful state of mind and asked for his discharge. Up to June 23, 1901, when I last saw him, he gradually improved and had no rise of temperature although every day many crescents were present in his blood.

1901

Case 7


June 5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Group No. 1
Group No. 2
Group No. 1
Group No. 2
Posterior Half of Group No. 1
Anterior Half of Group No. 1
Group No. 2
Posterior Half of Group No. 1
Anterior Half of Group No. 1
Group No. 2
Posterior Half of Group No. 1
Anterior Half of Group No. 1
105°
104°
103°
102°
101°
100°
99°
98°
97°
96°
41°
40°
39°
38°
37°
36°
35°

Case No. 7.

Malarial Case No. 7.—C. C., Chinaman. Age 45. Mining coolie. Admitted to District Hospital June 5, 1901. Absconded June 24, 1901. Patient has been working at Kepong (Selangor) for the past eighteen months. A month or so ago he felt feverish and every third day thereafter, but it was not severe and he did not feel very sick. He took Chinese medicine but it did not cure him, so he came here. Says he has fever every day or second day, comes about 5 p.m. and leaves about 8 p.m. Appetite fair. Spleen only slightly enlarged. Thinks he will have fever to-morrow.

June 6, 1901.—Had a rigor to-day at 4 p.m. He scarcely knew it, but sat up and smoked and chatted freely.

June 7, 1901.—Had a slight but distinct rigor about 8 p.m. Complained of slight pain over whole of body.

June 8, 1901.—No fever to-day. Feels well and wants to be discharged.

June 9, 1901.—A slight rigor to-day at 8 p.m. Did not complain much.

June 11, 1901, 10-30 *a.m., Temp.* 97.3.—Spleen slightly enlarged. Says he is not uncomfortable. No headache, vomiting or diarrhœa. Blood contained many small, lazy, clearly defined parasites about one-fifth the size of hosts. A few rods and grains of sluggish pigment in them. There is much free pigment and many pigmented leucocytes.

A group of almost mature parasites also present. They nearly fill their hosts. The latter are not enlarged but are almost colorless. In several the pigment is arranged in radial striæ and faint outlines of segmentation are to be seen.

4-30 *p.m., Temp.* 98.3, *rising.*—Many forms present with pigment in radial striæ. Three forms with centrally massed pigment and eight or seven distinct lines of cleavage and nuclei. One of these at 5 p.m. broke down into 8 spores. Several large extra corpuscular bodies.

June 14, 1901, 11-20 *a.m., Temp.* 98.—Patient is in a fair frame of mind. Blood contains many infected red cells. Parasites vary from half to two-thirds the size of hosts, are roundish, well defined and exhibit little or no movement. Pigment is fairly abundant and composed of dark red rods and granules rather coarse. It is mostly peripherally situated and oscillates distinctly but lazily.

A few almost decolorised but not shrunken or enlarged red cells contain parasites with pigment arranged in three or four radial striæ. A few highly refractile dots in the periphery and several lines of division are observable. A few very young Quartans are also present. This makes three distinct generations present and indicates an irregular Quotidian chart from now out.

June 15, 1901.—At 8 p.m. last night patient had a rigor. This morning at 9-30 a.m., Temp. 99.4, the immature forms of yesterday have developed considerably, the pigment is scant and lazy.

There are many mature parasites present, but none showing striation.

A few epi-corpuscular and small endo-corpuscular forms present.

June 18, 10-50 *a.m.*, *Temp.* 98.1—An almost mature and a half-grown group of parasites present. Pigment coarse, fairly plentiful, with sluggish movement.

2-20 *p.m.*—Many Quartan parasites in the act of sporulating. Only the rims of the hosts can be seen. They will produce 7 to 10 spores.

A second generation is present in large numbers. Its members are about two-thirds the size of hosts.

A third generation very scant and small also to be seen.

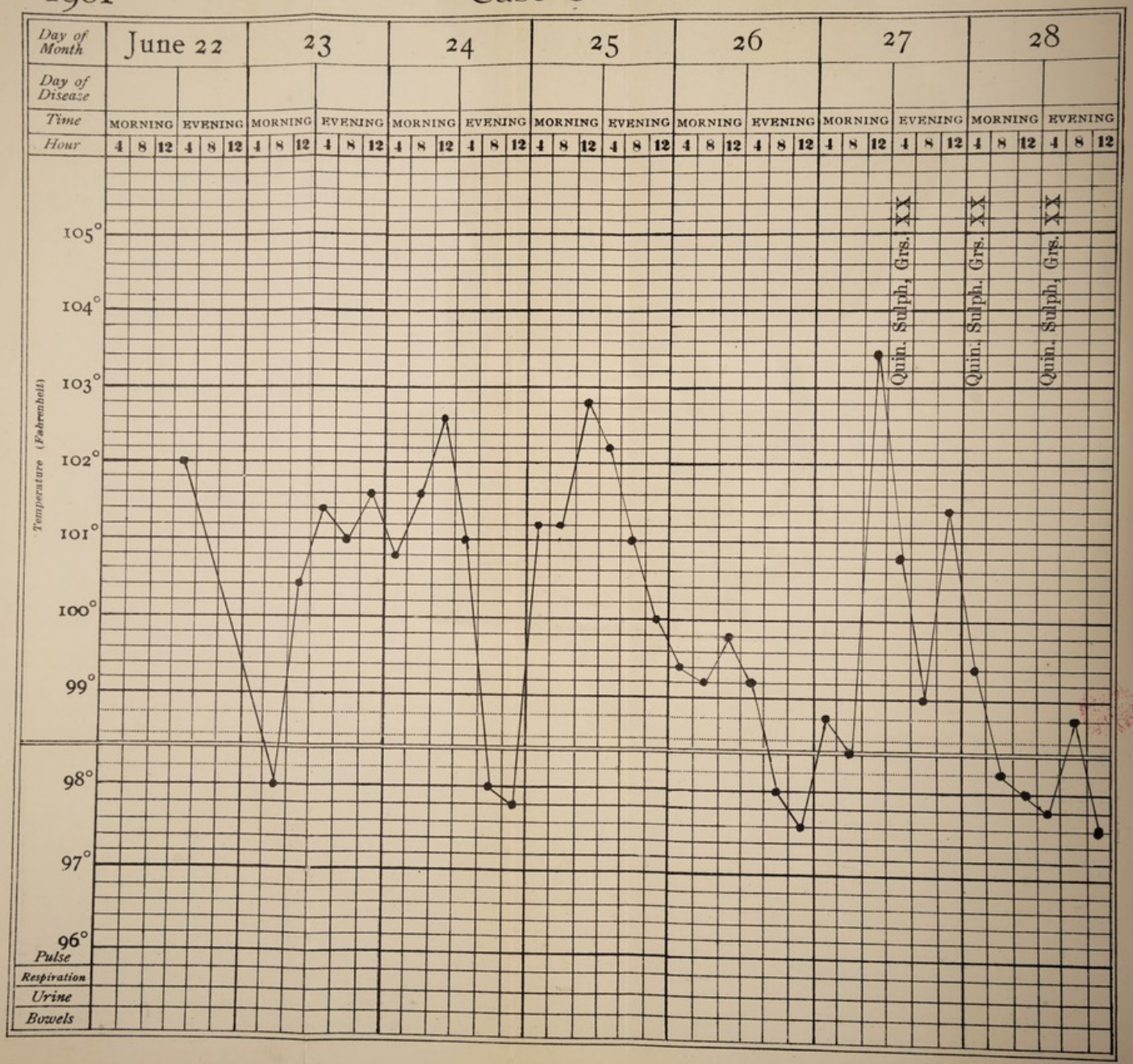
The flagellate bodies seen to develope. Pigment in quantity, also numerous pigmented leucocytes.

4 *p.m.*—Sporulating forms rare. Other groups have not much changed.

June 18, 1901.—Patient says he is well though quinine has been purposely withheld and his blood is loaded with Quartan parasites. He continued to have a rise of temperature (*see* Chart) every day till the 22nd. Following a dose of quinine sulph. grs. 10 on the 21st at 8 a.m. temperature fell. On the 22nd another dose of 20 grs. was given and there was no further pyrexia up to the time he absconded on the 24th. Grs. 30 of quinine seemed to have killed the myriads of fever forms. The patient was only slightly inconvenienced by his fever. His attacks were not always characteristically divided. This I find to be the case in most Quartans.

1901

Case 8


Day of Month
June 22
23
24
25
26
27
28
Day of Disease
Time
MORNING
EVENING
Hour
4 8 12
Temperature (Fahrenheit)
105°
104°
103°
102°
101°
100°
99°
98°
97°
96°
Quin. Sulph. Grs. XX
Quin. Sulph. Grs. XX
Quin. Sulph. Grs. XX
Temperature (Centigrade)
42°
41°
40°
39°
38°
37°
36°
35°
Pulse
Respiration
Urine
Bowels

Case No. 8.

Malarial Case No. 8.—*L. K., Chinaman. Age* 32. Mining coolie. Admitted to District Hospital June 22, 1901. Discharged July 4, 1901. Patient has been working at surface mining at Kepong (Selangor) for the past two years. Fifteen days ago he had a first attack of cold and hot fever. Every third day at first but lately almost every day. So came to hospital for treatment. Has not taken quinine. Complains of fever coming on daily at 10 a.m. and generally quitting him at 3 p.m. Temperature on admission 102. Appetite poor. Ten movements of bowels to-day.

June 24, 1901, 7-45 *a.m.*—Patient is shivering, feels cold and vomits. Tongue furred and dry. Spleen enlarged and tender.

11-30 *a.m.*—Blood contains forms of the Malignant Tertian about half the size of hosts. Pigment is densely massed excentrically, rarely centrally, and is wholly quiescent. Plasmodia pale and quiescent but no distinct lines of disruption to be made out. These are probably laggards of the group that sporulated earlier in the day.

A second generation of ringlets and discoids is present. The scant peripherally-situated pigment is oscillating rapidly. They are about half grown. Crescents are numerous. Free pigment is plentiful.

6 *p.m.*—Three distinct groups of Malignant Tertians are now observable:

(1) A group of very young actively amœboid forms that occasionally can be seen to form ringlets and then return to activity. A few epi-corpuscular forms made out by oblique illumination.

(2) A group of median size discoids almost motionless; also of rings. A few fine oscillating pigment grains in the periphery.

(3) A few forms almost mature. They are clear, refractile, rounded, nearly two-thirds the size of their hosts with a dense mass of quiescent pigment slightly excentric. A rigor should occur shortly.

Many brassy shrunken bodies present.

June 25, 1901, 7 *a.m.*—Patient had a rigor early this morning (group 3 had sporulated). He looks tired. Bowels opened five times since 4 a.m. Has vomited once. Tongue dry and coated. Temp. 100.1. An almost mature group of parasites present, probably group No. 2 of yesterday. A second group about half developed; probably group No. 1 of yesterday evening.

Patient had a second attack of fever about 11 a.m. to-day.

June 26, 1901.—Patient distressed. Has been feverish almost all day.

June 27, 1901, 11 *a.m.*, *Temp.* 103.—Patient distressed. Spleen tender. Says he has fever all the time. Blood contains many crescents. Also quite a number of rounded slightly amœboid parasites about a quarter the size of hosts. A small block of pigment is forming, towards the periphery; a few grains are still detached and oscillating.

A second group of discoids and rings to be seen. Pigment grains scant, peripherally-situated, slightly oscillating. Also a small number of very small, extremely active amœboid bodies that occasionally develope into ringlets. Much free pigment and many pigmented leucocytes present.

The power of quinine to destroy fever forms of the Malignant Tertian could not be better exhibited than by this case. Grs. 20 of quinine sulph. was given per oris at 4 p.m. to-day as the temperature was descending. It must have killed the youngest forms. No rigor occurred on the 29th. A second dose of 20 grains was given at 4 a.m. as the temperature was descending. Only twice did the temperature go above normal during the seven days following, when patient was discharged.

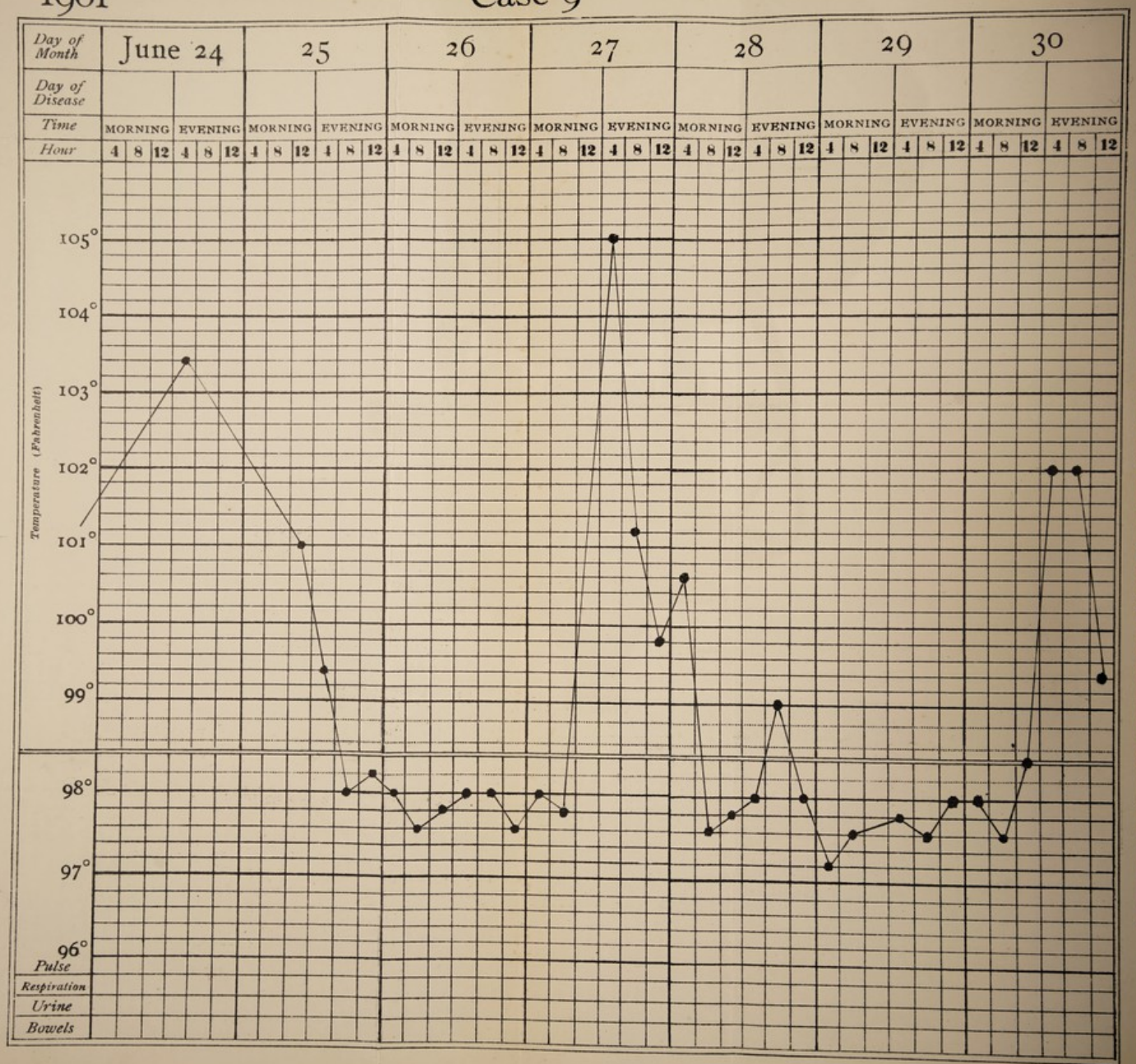
July 1, 1901, 9-35 *a.m.*, *Temp.* 97.6.—Crescents only present.

July 3, 1901, 11-20 *a.m.*, *Temp.* 98.2.—No fever form. Crescents numerous.

July 4, 1901, 10-30 *a.m.*, *Temp.* 97.4.—Crescents still numerous. Grs. 20 quinine sulph. given and patient discharged.

1901

Case 9


Day of Month
June 24
25
26
27
28
29
30
Day of Disease
Time
MORNING
EVENING
Hour
4 8 12 4 8 12
105°
104°
103°
102°
101°
100°
99°
98°
97°
96°
Temperature (Fahrenheit)
Pulse
Respiration
Urine
Bowels
42°
41°
40°
39°
38°
37°
36°
35°
Temperature (Centigrade)

Case No. 9.

Malarial Case No. 9.—*A. K., Chinese. Age* 32. Admitted to District Hospital June 24, 1901. Discharged July 8, 1901. For the last year has worked as a mining coolie at Rawang (Selangor). Two weeks ago had a slight attack of fever then again three days later, and every fourth day since. Has not taken quinine. Fever begins generally at 2 p.m. and leaves about midnight. Spleen slightly enlarged. Bowels regular. Appetite good.

June 26, 1901, 8 *a.m.*—Numerous well defined lazy plasmodia about a third the size of hosts. Their movement is sluggish. Several dark rods and granules are present, slowly swarming. A few pigmented leucocytes seen.

June 27, 1901, 8 *a.m.*—Many almost mature Quartan parasites present. Several have their pigment in two or three radial striæ and faint signs of division into seven to nine parts can be observed. The nucleus of each spore can be made out. 10 *a.m.*—Many sporulating forms present. Free pigment is more plentiful.

Patient had a slight rigor at 9 a.m., June 28, 1901. Patient does not complain. Slight œdema of face and ankles. 12 *noon.*—Several plasmodia one-fourth the size of hosts. A few pigmented leucocytes.

June 29, 1901, 10 *a.m.*—Plasmodia have grown considerably and are almost quiescent. The rods and granules of pigment still lazily move. They now fill nearly two-thirds of their hosts. The latter are unchanged.

June 30, 1901, 8 *a.m.*—The parasites fill their hosts. Only a pale segment of the latter visible in the majority of instances. Pigment is almost quiescent and in most cases is arranged in radis.

12 *noon*, *Temp.* 98.4.—Many sporulating forms. Patient has had some slight chilly feelings for the past hour but complains of nothing else.

4 *p.m.*, *Temp.* 102.—Several sporulating forms seen to disintegrate into from 7—9 spores. Some free pigment.

June 1, 1901, 8 *a.m.*, *Temp.* 98.—Quinine sulph. grs. 20 given.

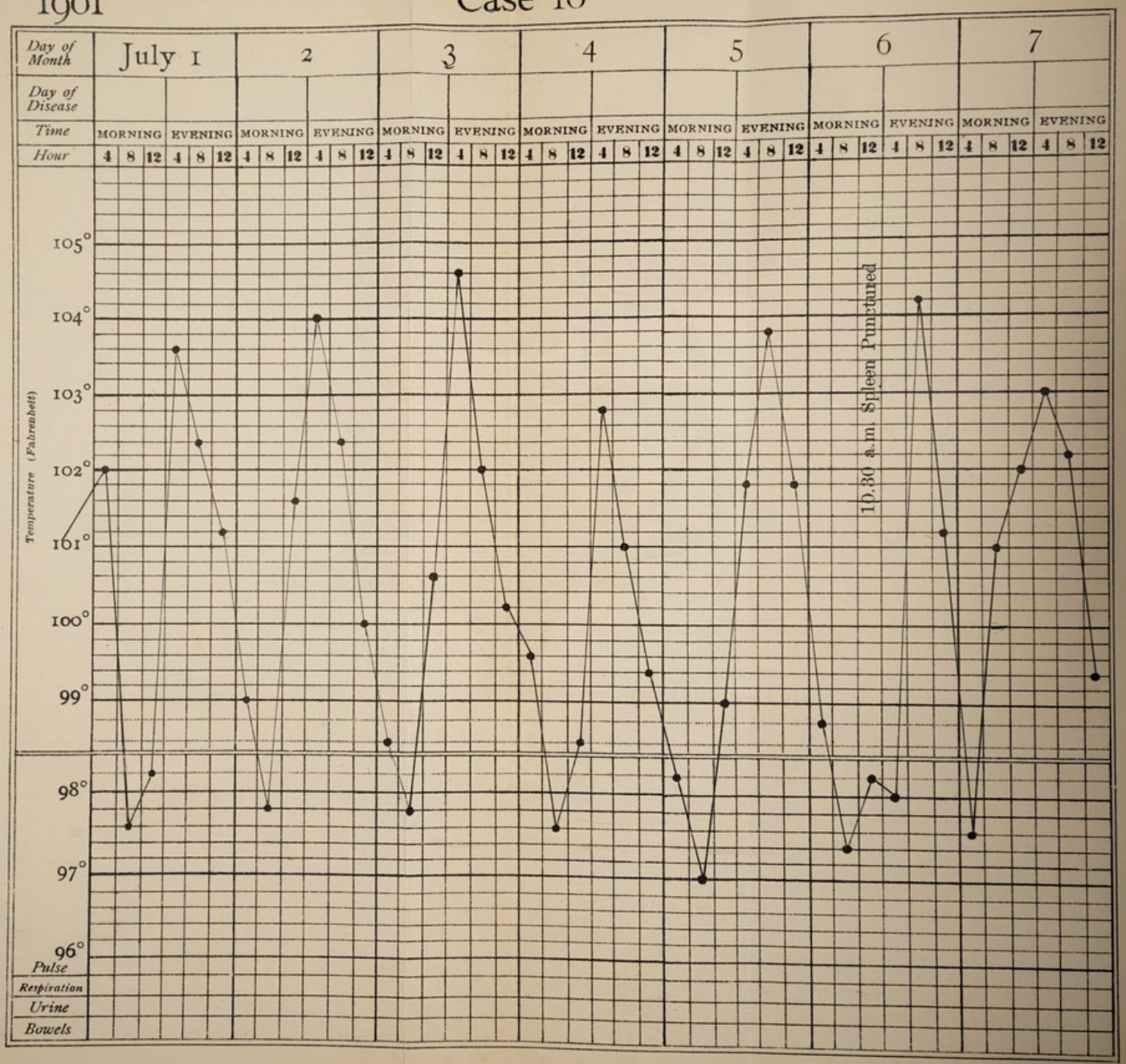
9-55 *a.m.*, *Temp.* 97.6.—Many plasmodia slightly pigmented, about a quarter the size of their unchanged hosts and showing sluggish movement. Several of these seen to burst out into plasma leaving their hosts wrecked. A few smaller more active unpigmented forms seen, probably laggards. One or two phantom cells seen. A scant amount of free pigment and a few pigmented leucocytes present.

8 *p.m.*—Quinine sulph. grs. 20.

A few half grown Quartans were observed on July 2, 1901, but they or their spores must have been soon destroyed by quinine as no further rise of temperature took place after June 30, 1901. I saw no more parasites in this patient's blood after the third exhibition of quinine on July 2, 1901, 8 p.m.

1901

Case 10


Day of Month
July 1
2
3
4
5
6
7
Day of Disease
Time
MORNING
EVENING
Hour
4 8 12 4 8 12
105°
104°
103°
102°
101°
100°
99°
98°
97°
96°
Temperature (Fahrenheit)
10.30 a.m. Spleen Punctured
42°
41°
40°
39°
38°
37°
36°
35°
Temperature (Centigrade)
Pulse
Respiration
Urine
Bowels

Case No. 10.

Malarial Case No. 10.—*C. C., Chinaman. Age* 25. Mining coolie. Admitted to District Hospital June 30, 1901. Five months ago came to Pudoh, near Kwala Lumpor, and worked there at tin mining till admitted here for fever. Ten days ago (June 15, 1901) he had a first attack of fever which occurred about the same time during the following days. He is first cold for a short time, then hot for a few hours, then all right again till next day.

July 2, 1901.—Patient looks well. Does not complain except that he gets cold and hot every day. Appetite fair. No vomiting. Spleen slightly enlarged but not painful.

10-15 *a.m.*, *Temp.* 97.8.—One doubtful small parasite with but slight movement observed. Free intensely black pigment in fine grains and clumps seen. Also a few pigmented leucocytes. No crescents.

2-30 *p.m.*, *Temp.* 98.2.—Blood same as at 10-15 a.m., except no plasmodia of any kind observed.

6 *p.m.*—Same as at 2.30 p.m.

July 3, 1901, 8-30 *a.m.*, *Temp.* 97.—Small amount of free pigment alone seen.

11-55 *a.m.*, *Temp.* 100.4.—Nothing to be seen except a few grains of intensely black pigment.

4 *p.m.*—Nothing seen of note.

July 4, 1901.—Patient does not complain.

8 *a.m.*, *Temp.* 97.3.—A small amount of free black pigment to be observed. No plasmodia. No crescents.

11-20 *a.m.*—Temperature same as at 8 a.m.

July 5, 1901, 8-30 *a.m.*, *Temp.* 98.—A few pigmented leucocytes.

12 *noon.*—Nothing of note.

This patient has had such characteristic Quotidian rises of temperature and such typical attacks of Malaria, but I can find nothing but pigment in his blood and that only subsequent to the pyrexia. It does not answer to the description or what I have seen of the Pigmented Quotidian here or the description of the Unpigmented Quotidian. Dr. McCLOSKY punctured the

patient's spleen at 10-30 a.m., July 6, 1901, Temp. 98.3. I saw two small forms about half the size of a red cell with fine actively swarming black pigment. I watched these for some time, but they did not develope flagellæ. These bodies were not of the crescentic series. They were seen immediately after the blood was drawn and before a crescent could have developed into a globular form. Further, no double contour was observable. They looked like almost mature parasites that, like the Benign Tertian, escape direct from their hosts into the serum.

I saw, in addition, two sporulating parasites that had just fallen asunder; one of nine and one of eight small highly refractile spores. One had a small central compact mass of very black pigment, the other a smaller and larger mass lying amongst the spores.

One only intra-corpuscular parasite was seen. Rounded, fairly distinctly outlined, quiescent and about a third the size of its unaltered host, it was finely pigmented, mainly in the peripheral layers. The pigment in fine grains was fairly active.

A considerable amount of free black pigment was present.

July 8, 1901, 11-30 *a.m.*, *Temp.* 100.—A large amount of free black pigment. A few pigmented leucocytes.

3-30 *p.m.*, *Temp.* 101.—Spleen again punctured. Saw a few intensely black clumps of pigment. Also two plasmodia similar to that described above, but a bit smaller. No crescents. 20 grs. quinine given at midnight.

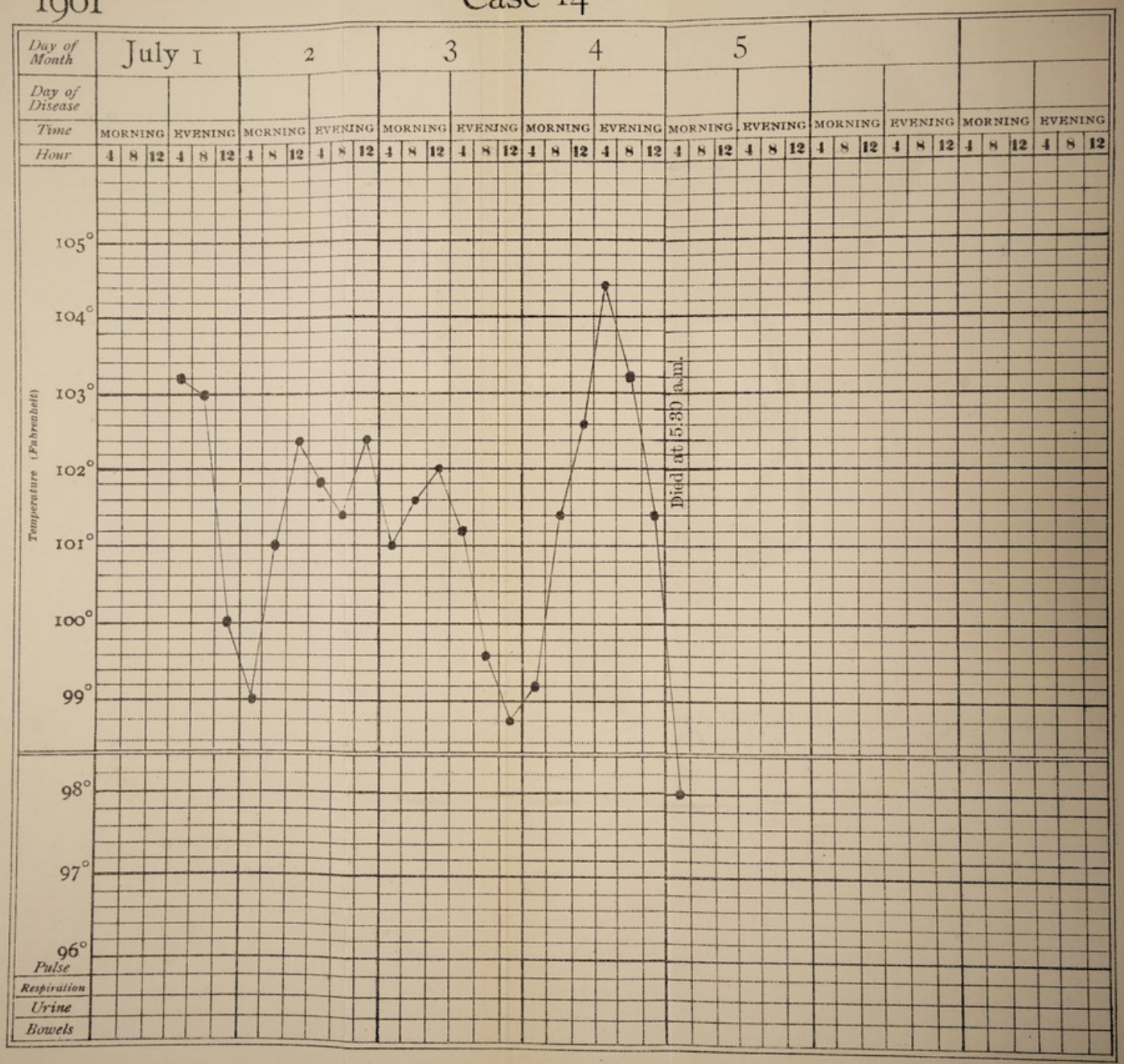
July 9, 1901, 8 *a.m.*, *Temp.* 98.—Grs. 10 quinine.

This is either a new type of Malarial fever or is an anomalous Pigmented Quotidian. Against the latter view is the fact that neither in the peripheral or splenic blood did I find the crescentic bodies of a Malignant fever. Further, no forms of any kind were at any time visible in the peripheral blood. The patient's chart is classically Quotidian, and he had the well marked cold, hot and wet stages of the Malarial attack. But he suffered not at all; had but few of the objective signs of Malignant fever.

It is impossible to look upon it as an Unpigmented Quotidian. No crescents were present yet there was, after each rigor, a noticeable amount of free pigment and a number of pigmented leucocytes. But this pigment instead of being derived from crescents as in the Unpigmented Quotidian, must have been produced and set free by the parasites I found in the splenic blood. The actively swarming pigment of these plasmodia places it out of the category of both the Unpigmented and Pigmented Quotidian. The sporulating bodies seen in the splenic blood seem to indicate a new type of parasite, what I feel for the present inclined to call Benign Quotidian.

1901

Case 14


Day of Month
July 1
2
3
4
5
Day of Disease
Time
MORNING
EVENING
Hour
4 8 12
Temperature (Fahrenheit)
105°
104°
103°
102°
101°
100°
99°
98°
97°
96°
Pulse
Respiration
Urine
Bowels
Died at 5.30 a.m.
Temperature (Centigrade)
42°
41°
40°
39°
38°
37°
36°
35°

Case No. 14.

Malarial Case No. 14.—*N. Y., Chinaman. Age* 40. Gardener. Entered District Hospital July 1, 1901. Died July 5, 1901. No one can tell from where he comes. Was slightly delirious when first seen at 2 p.m., Temp. 103.2. Body well nourished. Spleen enlarged. 8 p.m. unable to speak.

July 2, 1901.—Quinine grs. 30 at 8 a.m. Patient almost comatose. 11-10 a.m. Temp. 102.6. An enormous number of active unpigmented plasmodia and quiescent ringlets one-fifth the size of red cell. Many red cells doubly and trebly infected.

Many plasmodia one-third size of hosts active, a few grains of fine pigment oscillating in the peripheral layers. There are many shrunken spiculated brassy bodies containing generally a slightly pigmented ringlet.

A third group—one to every fourth field—is present. The plasmodia are about one-half to two-thirds the size of their hosts, are situated excentrically, and contain a dense mass of black pigment also excentrically placed.

Many crescents. Much free pigment and pigmented leucocytes are numerous.

I did not see patient again as he died at 5-30 a.m. July 5, 1901. This is one of the severest infections I have observed. It appears to have been a multiple Malignant Tertian with an almost continuous pyrexia.

Case No. 15.

Malarial Case No. 15.—*P. A., Tamil. Age* 30. Railway coolie by occupation. Admitted to District Hospital July 7, 1901. Discharged July 1, 1901.

July 7, 1901.—Patient entered hospital, slightly delirious and unable to give a clear account of himself. Temperature at 5 p.m. 101.4. Bowels opened shortly after admission.

July 8, 1901.—Patient had distinct rigor this afternoon. Cold, hot and wet stage marked.

July 9, 1901, 5-38 *a.m.*—Complains of thirst and general weakness. Spleen enlarged and tender. He is dull mentally.

9-45 *a.m.*, *Temp.* 97.4.—Blood contained many multinuclear leucocytes, several of them pigmented. Several globular bodies of the crescentic series observed with polar globules (?) extruding. A few discoids and ringlets seen about a fifth the size of hosts, a few grains of wholly inactive pigment in their periphery. There are, in addition, several parasites about a third the size of hosts, round, well defined, with a dense block of pigment in each situated excentrically. Lines of cleavage can be observed in organisms. Red hosts shrunken and shrivelled. A few young crescents observed.

2-40 *p.m.*, *Temp.* 98.—Not so many of the larger parasites of this morning present. But they seem to have advanced considerably. One was observed to sporulate and break up into eight spores.

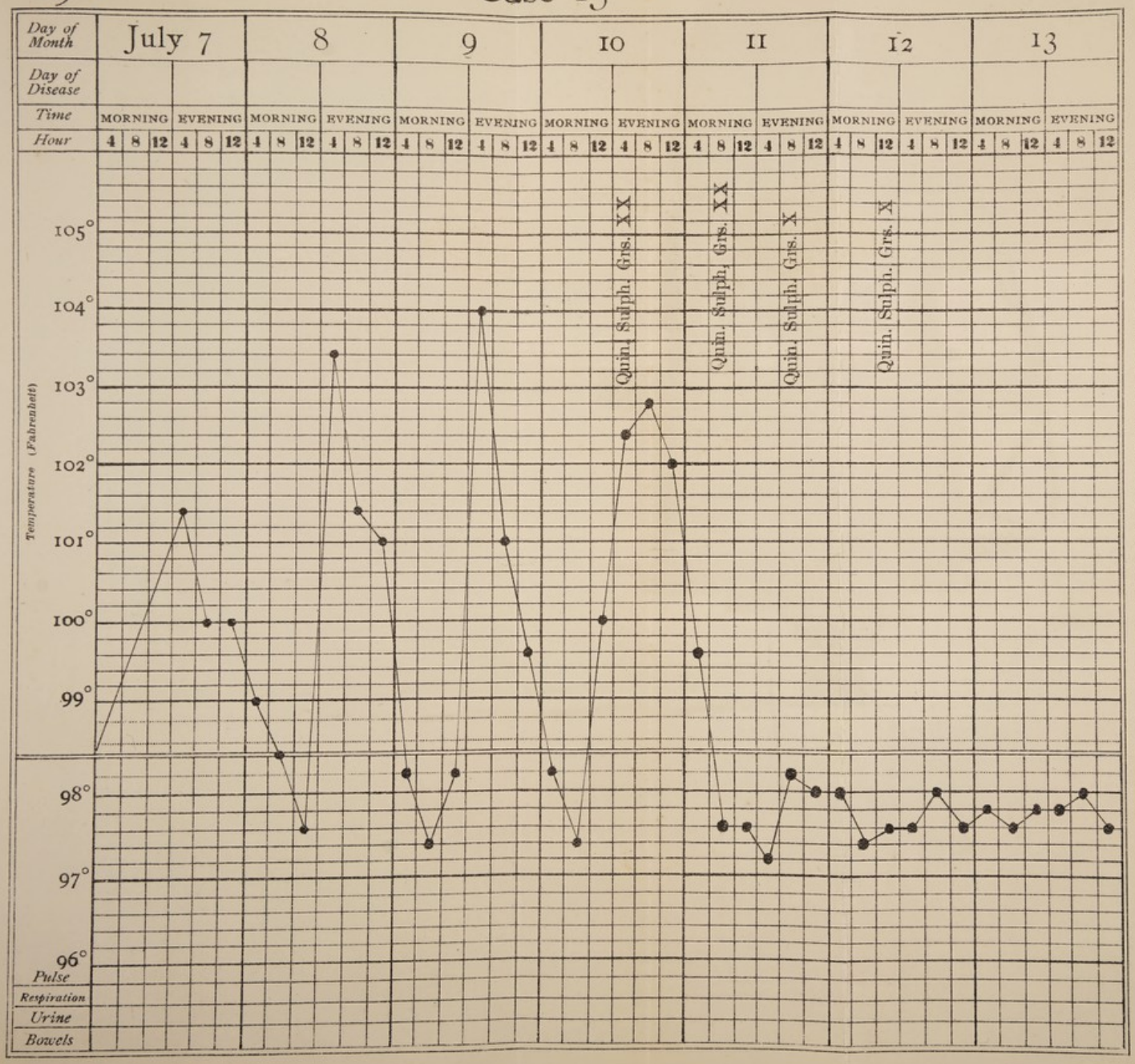
July 10, 1901.—Patient gave the following account of himself this morning. A year ago came from India to work at Serdang (Selangor). One month ago he had a first attack of fever with distinct cold, hot and wet stages. An attack occurred every following day with severe vomiting and diarrhœa.

8-35 *a.m.*, *Temp.* 97.3.—Several immature crescents seen. Many ringlets $\frac{1}{4}$ the size of hosts. They are wholly quiescent. A few fine black pigment grains wholly motionless present in the periphery of each. Many doubly infected cells observable. Several couples of syzygies appear to be conjugating. Copper coloured shrunken bodies numerous, each containing a ringlet of small size. A few pigmented multinuclear leucocytes present.

3 *p.m.*, *Temp.* 101.—One sporulating body observed. It was situated in the centre of its shrunken host. Its pigment was massed excentrically, eight lines of cleavage observed. No mature but many immature crescents seen.

1901

Case 15


Day of Month
July 7
8
9
10
11
12
13
Day of Disease
Time
MORNING
EVENING
Hour
4 8 12 4 8 12
Quin. Sulph. Grs. XX
Quin. Sulph. Grs. XX
Quin. Sulph. Grs. X
Quin. Sulph. Grs. X
Temperature (Fahrenheit)
105°
104°
103°
102°
101°
100°
99°
98°
97°
96°
Temperature (Centigrade)
42°
41°
40°
39°
38°
37°
36°
35°
Pulse
Respiration
Urine
Bowels

3-30 *p.m.*—Quinine sulph. grs. 20 given. Further doses of quinine given at 8 a.m. and 8 p.m. July 11, 1901, and at 12 noon, July 12, 1901. No further rise of temperature.

July 16, 1901.—Several mature and a few immature crescents. No fever forms.

July 17, 1901.—One crescent seen to flagellate at 9-30. a.m., half-an-hour after blood was drawn. Many mature crescents. No fever forms. It seemed to me that this was a true Pigmented Quotidian. Only one group of parasites was present and a daily rigor occurred corresponding with the maturation of the plasmodia.

Case No. 20.

Malarial Case No. 20.—Hansan. Malay. Gardener by occupation. Age 47. Admitted to District Hospital July 11, 1901. Discharged July 20, 1901. Was born in Singapore. He has during the past few years had many attacks of fever like this one. Cold, hot and wet fever with much vomiting and diarrhœa every day. Generally he gets well in a week or so without taking medicine. Sometimes he takes quinine and then he gets well sooner. For the past year he has lived at Ayer Itam near Kwala Lumpor. The present attack began seven days ago, and he has had fever once a day since. His spleen is greatly enlarged and tender. On admittance at 2 p.m. Temp. was 104.4.

July 12, 1901.—Had a severe rigor at 5-30 p.m.

July 13, 1901, 8-50 *a.m.*—Several shrunken red cells seen containing small almost mature parasite. Latter are round, well defined, about a third the size of hosts and contain a dense clump of dark pigment towards one side. Rigor at 3 p.m. to-day.

July 14, 1901, 11 *a.m.*—Many multinuclear white cells; a few contain pigment. No parasites of any size or shape to be found. Several crescents to be seen. Rigor at 4-30 p.m. At 5 p.m. Temperature 101.2. I observed several epi-corpuscular amœbulæ by oblique illumination. A few smallest size amœbulæ are seen inside red cells. They are very active, but soon form into small quiescent ringlets or discoids. A small amount of free pigment, intensely black, is observable, and one pigmented multinuclear leucocyte.

July 16, 1901, 10-30 *a.m.*—A few lazy plasmodia ¼ the size of hosts. After 20 minutes most of them have formed into ringlets with a few grains of quiescent pigment in the periphery. There is apparently only one group of parasites present.

By the clear daily rise and fall of temperature and the presence of only one group of parasites in the blood this Case seems to be a Pigmented Quotidian.

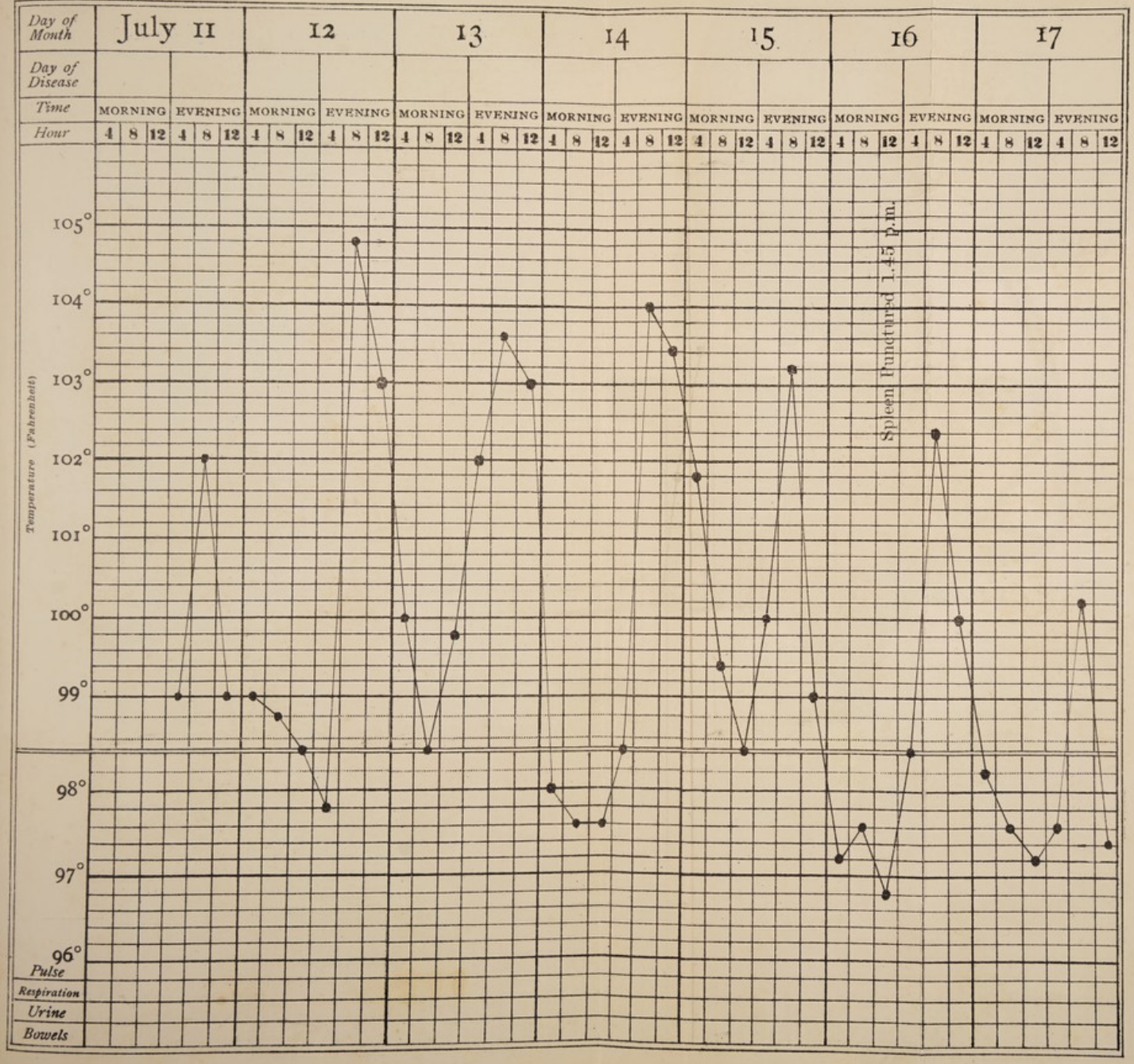
1-30 *p.m.*—No signs of parasites in peripheral blood. Temp. 98.1.

1-45 *p.m.*—Spleen punctured. Many infected red cells procured. The plasmodia are slightly larger than this morning, about a one-third the size of hosts. Pigment has increased. It is very fine, black and quiescent and wholly peripheral. It appears to be massing excentrically. Most of the hosts are shrivelled. Only one group of parasites to be observed. It certainly seems to be a case of Pigmented Quotidian.

This patient continued to have rigors till the 18th when spontaneous cure set in. He had no quinine while in hospital. Examined on the 20th before discharge I found no fever forms, but a few crescents. I have tabulated it as a Pigmented Quotidian.

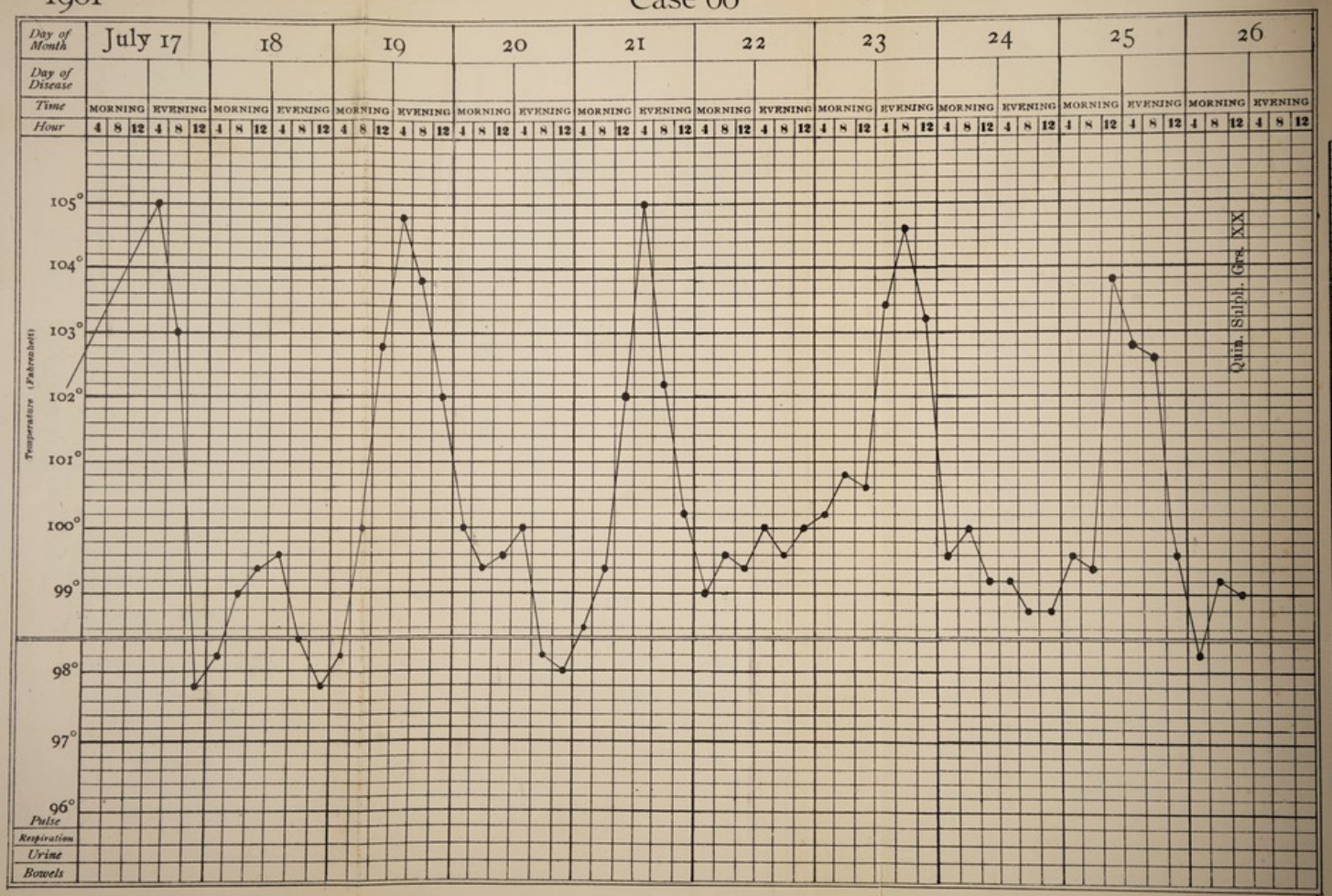
1901

Case 20


Day of Month
July 11
12
13
14
15
16
17
Day of Disease
Time
MORNING
EVENING
Hour
4 8 12 4 8 12
105°
104°
103°
102°
101°
100°
99°
98°
97°
96°
Temperature (Fahrenheit)
Spleen Punctured 1.45 p.m.
42°
41°
40°
39°
38°
37°
36°
35°
Temperature (Centigrade)
Pulse
Respiration
Urine
Bowels

1901

Case 60


Day of Month
July 17
18
19
20
21
22
23
24
25
26
Day of Disease
Time
MORNING
EVENING
Hour
4 8 12 4 8 12
105°
104°
103°
102°
101°
100°
99°
98°
97°
96°
Temperature (Fahrenheit)
Pulse
Respiration
Urine
Bowels
Quin. Sulph. Grs. XX
42°
41°
40°
39°
38°
37°
36°
35°
Temperature (Centigrade)

Case No. 60.

Malarial Case No. 60.—*C. W., Chinaman. Aged* 27. Admitted to Kwala Lipis Gaol Hospital July 17, 1901, complaining of fever.

July 25, 1901.—Patient arrived from China two years ago to work at the Kuantan (Map E 3) tin mines. Has had several attacks of fever. Took quinine at once and got better. Four-and-a-half months ago was sent to Gaol. Eight days ago had fever for the first time in Gaol and every second day since. Is still suffering from it having had no quinine.

10-30 *a.m., Temp.* 102.2.—A few red cells infected by a parasite about two-thirds their size. Parasites excentrically situated. Pigment massed in their edge. No other fever forms present. A few crescents observed.

July 26, 1901, 11 *a.m.*—Many ringlets and discoids in peripheral blood. A few actively motile plasmodia which form themselves into ringlets and then break down into active bodies again. None of these parasites larger than a third of their hosts. A few of the discoids show a grain or two of actively oscillating pigment in their peripheries. A few crescents.

This is undoubtedly a single infection by the Malignant Tertian parasite.

Case No. 99.

From

M. M. Connolly, M.D.,

District Surgeon, Batu Gajah.

The pernicious fever of the nature described in the following case is unusual in the Malay Peninsula, and a few details are therefore advisable.

The patient, Mr. E., an engineer in the Public Works Department of Perak, fell ill, as I was informed, at Kuala Kangsar on the 6th of June, when he had copious bilious vomiting and high fever.

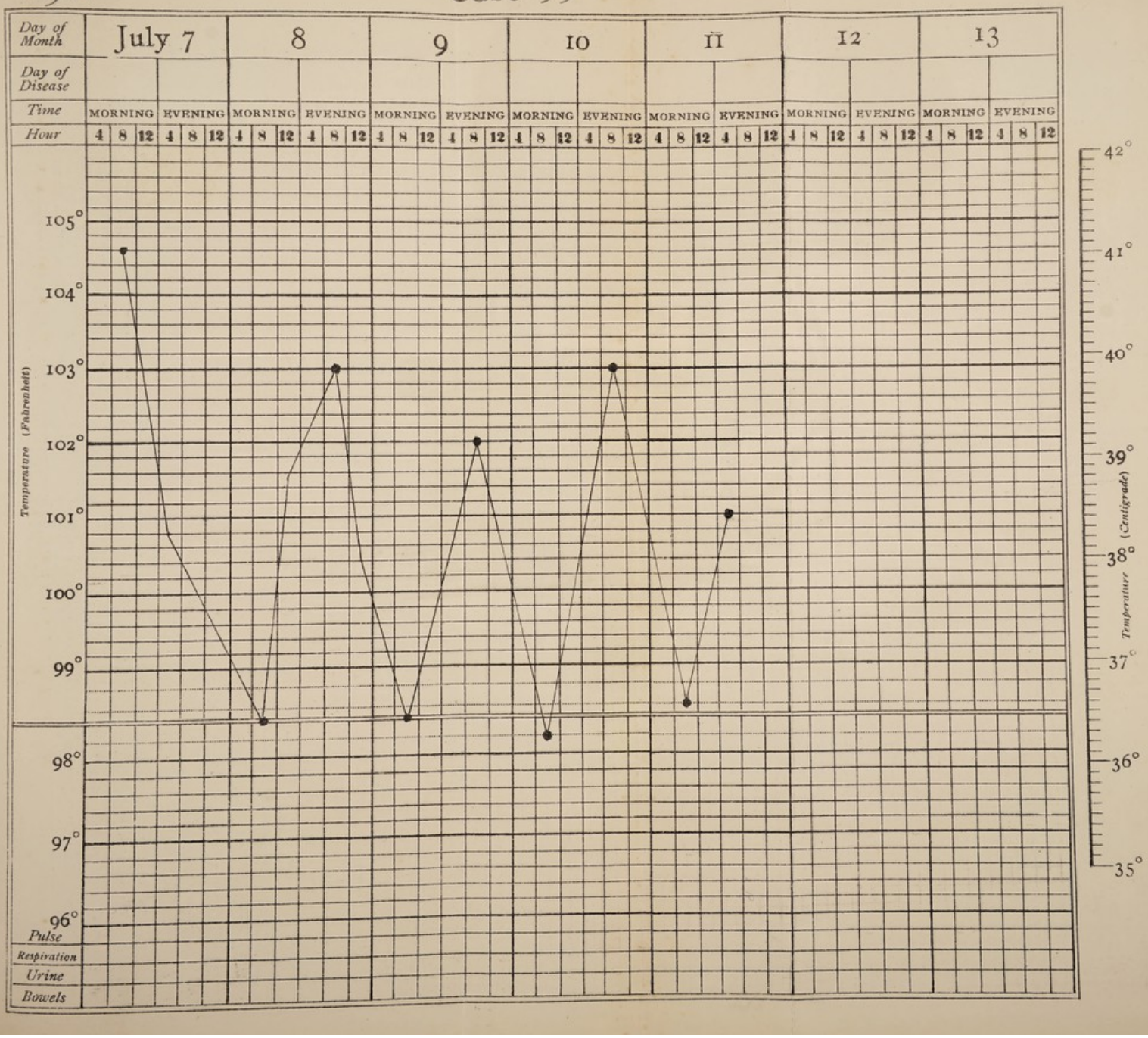
On the 7th his temperature was 104.6, and the bilious vomiting continued. On the 8th the temperature was normal in the morning, in the evening rose to 103, and as before there was bilious vomiting. On the 9th the temperature was again normal in the morning, in the evening 102, and bilious vomiting also continued. On the 10th it was also normal in the morning, in the evening 103 and vomiting had apparently ceased. On the 11th he was found quite jaundiced, having apparently changed colour in about 3 hours. In the afternoon of that date he was conveyed to the European ward at Batu Gajah Hospital. He was then of a deep saffron-yellow colour, which was quite visible through the hair over the scalp, in the sclerotic, in the mucous-membranes and over the whole body. He was manifestly very feeble. The temperature was 101, the pulse 96, fairly full but compressible. The extremities were cold, there was great headache, nausea, anorexia and insomnia. He had been slightly delirious at Kuala Kangsar, but gave a connected account of his illness when questioned. He stated that he last saw urine on the afternoon of the 9th, which he described as fairly abundant and like red ink, but the catheter drew off about 6 oz. of urine, which very much relieved him. It was not red, but was of a bilious colour and gave a reaction for bile pigments. It contained albumen.

He was now treated symptomatically and vigorously, and every attempt was made to induce sleep, to support strength, and to check further blood destruction, which was considered to be the cause of the discolouration. Champagne was given freely, and normal saline solutions were copiously injected into the rectum.

The result of the post-mortem leads to the belief that though the liver was of colossal size, and though the kidneys were enlarged, the spleen may be considered as the real seat of the malady. The disintegration of the blood corpuscles which proceeded without restraint was probably the cause of the small size of that organ. It is therefore likely that in such a case cathartics are injurious, and that the only logical treatment would consist of stimulating support to the system of what might be termed blood antiseptics, of injections of saline solutions and of transfusion of blood.

1901

Case 99


Day of Month
July 7
8
9
10
11
12
13
Day of Disease
Time
MORNING
EVENING
Hour
4 8 12 4 8 12
105°
104°
103°
102°
101°
100°
99°
98°
97°
96°
Temperature (Fahrenheit)
42°
41°
40°
39°
38°
37°
36°
35°
Temperature (Centigrade)
Pulse
Respiration
Urine
Bowels

Cholagogue cathartics, diluents, and diuretics, cupping to the loins, absorbents over the hepatic region, inunction of creosote, and intramuscular injection of quinine were some of the remedies employed.

The accompanying chart shows his temperature.

From the beginning little hope of his recovery was entertained, though the kidneys reacted well to drugs, and the skin was nearly always moist. It had been noticed on examination, after entry into hospital, that he was suffering from a mitral regurgitation, and had an enormously enlarged liver.

A slight hiccough was noticed on the 13th, and on the morning of the 14th, after some broken sleep during the night, his temperature fell to normal.

The stools were characteristic. They seemed composed of a slightly mucous material of mud colour, but on the 15th were coloured with blood.

Melæna now set in and later stools were passed involuntarily, containing a dark greenish-looking mucus stained with blood.

Signs of anæmia and adynamia were manifest, and cramps seized the muscles of both extremities.

Urine was passed freely to the end.

The peculiar hue of the skin intensified with the progress of the disease, and death occurred quietly from exhaustion on the 17th.

Post-mortem four hours after Death

The skin of the entire body was coloured a vivid yellow which varied from deep saffron to bright brass; the ears, cheeks, nose, hands and feet showed no difference from the hue of the abdomen and thighs. The conjunctivæ were also stained yellow. The scleræ, the mucous membrane of the lips, gums, mouth and tongue were also stained. Post-mortem rigidity was exceedingly marked.

On dissection it was found that the staining extended through the deep connective tissues, through the scalp and through the peritoneum.

The muscles of the thorax and abdomen had their sheaths unmistakeably discoloured, and the muscle-fibres were quite dry like exposed meat.

The perichondrium of the costal cartilages was stained markedly, but the colour of the periosteum was changed in a less degree. The adipose tissue through the entire body was stained a uniform yellow.

The dura mater displayed the same staining, as well as the arachnoid and pia mater in a much less degree; the choroid plexus was discovered to have the same hue and the fluid in the lateral ventricles was also slightly yellow.

The brain weighed 50½ ounces, and was not discoloured so far as could be discerned by the naked eye.

The pericardium, like all other serous membranes, showed intense saffron-yellow staining, and the pericardial fluid exhibited the same characteristic. The heart weighed 11 ounces, the left ventricle was hypertrophied to an extraordinary extent; the mitral valve had small fibrous vegetations thickly strewed over it—there was a pronounced mitral murmur noticed during the illness—and the aorta was also dyed a yellow tint with a slight roughness above the valves.

The lungs were ashen-grey but dyed with the peculiar bright brassy tint visible in the skin; purple patches were numerous through the lobes and the bases were of a uniform purple colour naturally due to hypostatic congestion.

The liver was enlarged uniformly, and weighed 84½ ounces. The capsule was normally adherent, and the external colour showed little variation from the normal. On section, however, the cut surface betrayed the yellow stain, and there was much oozing of a fluid dark like congested blood interspersed with a yellow liquid. The gall-bladder was half full and contained a grumous alkaline fluid of a dark green-black colour. There was no obstruction to the common bile-duct.

The spleen weighed 5½ ounces only, the capsule was adherent, but the spleen substance was very soft and wanting in consistence. It was of a crushed raspberry colour.

The kidneys weighed 10 ounces each. They looked enormous. The capsule was not tightly adherent, and they looked typical specimens of the large white kidney uniformly stained yellow through cortex and medulla. A considerable amount of blood oozed on pressure. The bladder contained about 6 ounces of dark yellow urine with a large deposit.

The stomach appeared normal and was partly filled with a dark alkaline fluid.

The small intestines were covered with a greenish-black mucous material, and there were small hæmorrhagic puncta scattered everywhere throughout the bowels. The large intestine contained material of the same character coloured of a more red blood line towards the rectum.

The pancreas was enlarged and was also coloured yellow. The blood was fluid in the thorax, abdomen and cranium, having a deep claret colour. No clots were visible.

An Outbreak of Quartan Fever associated with Disturbance of Soil, but not due to it.

From Notes supplied by

W. R. C. MIDDLETON, M.B.

Municipal Health Officer, Singapore.

Kallang lies just outside Singapore town about two miles beyond the reservoirs. The ground is rolling; the hills and ridges planted with pine-apple. The valleys are shallow and wide and, besides running water, are the seats of pools of various sizes. On the right of the main depression earth work in connection with a scheme to increase the Singapore water supply is being carried on. The general composition of the soil in this spot is a mixture of clay and laterite. There is a substratum of mangrove debris; below this red clay and arenaceous clay. At the head of the main flat is an overseer's bungalow. Thirty yards behind this are two sheds about 20 yards apart for the accommodation of coolies. These sheds are divided into compartments by wooden partitions that do not reach to the roof. I shall call these sheds *a* and *b*.

The only coolies working at Kallang on February 15th, 1901, were about 22 Javanese (see Table). They were chiefly employed on the reservoirs and work in connection with them. No Malarial fever existed amongst them at this time.

On February 15th, 1901, 93 Punjabis and Oorias from Assam arrived on the spot. Shed *a* was wholly given up to them. Shed *b* was occupied jointly by the Javanese and several of the new arrivals.

The overseer in charge of these men knew them well as he had employed most of them for three years in Assam in railway work. During the three years they had all suffered more or less from one or two attacks of fever a week; never from daily fever (probably Quartan).

In Assam the men were not protected from mosquitoes.

On arrival the Oorias were set to linking up a tramway about two miles long running through jungle between Kallang and the reservoir.

All the Punjabis, except four, and the Javanese were put to excavating, mostly red clay; or pile driving. The line of excavation ran through the site of old pig styes and the soil here had been polluted in some places to a depth of four feet.

Malarial fever heretofore unknown amongst the Javanese at Kallang, began about the 1st March to attack them severely. Many Punjabis shortly before this had had to quit work for the same reason.

As the Javanese left the excavation Punjabis replaced them. The Malarious men were given small doses of quinine, but were soon sick again. The Punjabis at work linking up the tram-line also suffered badly from fever.

On March 1st, 1901, a batch of Chinese was brought in to work at the excavation. They soon began to suffer severely from Malarial fever.

Judging from observation of the temperature curve the type of fever appeared to be Quartan.

It looks to a casual observer as though this outbreak of Malaria occurring shortly after the disturbance of soil was due to the latter.

But a more careful observation leads me to believe—

1st. That the Punjabis and Oorias went into healthy Kallang with the parasites of Quartan fever in their blood.

2nd. Anopheles and their larvæ are present.

3rd. The new comers slept without nets and near the heretofore uninfected Javanese.

4th. The Anopheles of the neighbourhood became infected and then transmitted the fever to the healthy Javanese.

The disturbance of soil was a factor only in so far as it necessitated the introduction of coolies who, unfortunately, were infected with Malarial parasite.

The accompanying Table speaks for itself. The February record is also true of the preceding months.

The first cases of fever amongst the Javanese occurred about the middle of March, 25 or 26 days after the arrival of Punjabis on the spot, just sufficient time for blasts to develope in Anopheles and incubate in the men.

KALLANG WORKS.

LIST SHOWING NUMBER OF MEN EMPLOYED FROM THE MONTH OF FEBRUARY, 1901, TO 15TH AUGUST, 1901.
ALSO THE SICK DURING THE ABOVE PERIOD.

MONTH. 1901.	No of Men employed	No. of Attacks during the Month	Total No. present per month.	REMARKS
February	22 per day	Nil	616	
	February 15th, 1901. Introduction of infected Punjabis.			
March	68 per day	116 3.7 per day	2,108	1st cases amongst the Javanese about 12th March.
April	93 ,,	202 6.7 ,,	2,790	
May	104 ,,	447 14.4 ,,	3,224	
June	142 ,,	393 13.1 ,,	3,550	
July	153 ,,	354 11.4 ,,	4,131	
August (1st to 15th) ...	119 ,,	54 3.6 ,,	1,547	Quinine exhibited systematically.
TOTAL ...	701	1,556	15,966	

A NOTE ON MALARIA IN KLANG AND PORT SWETTENHAM

BY

MALCOLM WATSON, M.B.,

District Surgeon, Klang.

On the whole, the Malaria here seems to correspond in type with that found elsewhere in the tropics, causing the same amount of sickness and death, and leading to great depreciation of the individual.

Symptoms.

These are much as they are painted in the text book, only not quite so marked.

The cold stage usually exists and may last an hour, but in Klang it is uncommon to see a typical rigor. Although my dressers tell me they have seen it, I personally have yet to see the chattering of the teeth, tremor and blueness of the extremities that I have seen at home in a Malarial case.

The hot stage is, however, very commonly complained of, and the sweating stage usually follows after a short interval. Sometimes for a short time the patient may complain of being hot and sweating alternately, but this is usually where quinine has not been properly exhibited.

Headache is almost constant. In one case it alone was complained of. It had persisted outside, and resisted treatment with the usual remedies inside Hospital.

It was then noticed that his temperature chart showed slight irregularities, never more than 100 or 101, often less. Still there had been no complaint but of the headache. Quinine at once brought down the temperature, and the headache at once disappeared. Unfortunately no blood examination was made.

Vomiting is also common.

Constipation is almost a rule and its removal goes far in the cure.

Pain in spleen has been the most prominent complaint in several cases. As a rule it is hardly even tender to ordinary pressure.

Mental condition varies. In all there is a restless state, except in severe cases when coma comes on. This may come on suddenly and it is not uncommon to find death occurring in Malignant cases within a few hours of the patient appearing to be in a fairly good condition. The Malignant fever here often kills within ten days.

Malarial Cachexia is seen after all forms of the Fever, with its enlarged spleen, oedema of feet, ascites, and anæmia. Unless the temperature is taken as a routine the existence of fever at times in these cases may not be suspected. Parasites may be found in some cases when the temperature is normal.

Pains in the joints, especially the knees and in the calves of the legs are common after Malaria, but their exact relationship to Malaria seems uncertain.

Temperature.

My observations here are necessarily incomplete owing to no dressers being on duty at night and no temperatures being taken.

In almost every case, including those due to the Malignant parasite, at some part of the day the temperature is normal. In only a few cases has there been a febrile temperature from 8 a.m. to 8 p.m., and in these there has always been a remission. Possibly during the night temperature may have reached normal.

Except in the case of simple Quartan the temperature is not a guide to the form of fever. One sees Malignant cases typically intermittent, and coming down to normal in a few days without a grain of quinine. And I may add that most Malignant cases respond as rapidly to quinine as any Benign. In most cases the temperature rises about midday and fever is usually in the afternoon.

Variety of Parasites.

Benign Tertian, Benign Quartan and Malignant parasites are easily distinguishable.

A. Benign Tertian as a rule is found as a double infection, a brood maturing every 24 hours, and giving rise to a Quotidian Remittent and Intermittent Fever.

The parasite early developes pigment and very soon the cell enlarges and becomes pale. The pigment is intensely active up to the very last.

Three hours after being drawn, the pigment may be seen as active as ever.

The number of parasites seen has never been more than perhaps half of the number of red cells in marked contrast to the Malignant parasite. Benign Tertian rosettes are not commonly seen.

B. Benign Quartan is very different. The red cell is not enlarged, and it does not lose colour. The pigment is very sluggish even from the beginning. Its evolution is easily traced, rosettes being present in the peripheral blood before the temperature rises.

C. Malignant Parasites.

The different forms found which must be classed as Malignant are more difficult to understand and in an individual case quite a number of different forms may be seen. The crescent is obviously a non-febrile form ; in several cases where the temperature has been normal it is the only form seen. It appears even after the administration of quinine, but along with other forms it is found in febrile conditions often in great numbers. With it are usually found the oval or circular bodies.

In one case in which crescents, ovals and circulars alone were seen, the patient was semi-comatose and unable to speak. As he recovered it was observed by the dressers that the patient was bright and talkative in the morning, and could sit up for his food, while later in the day he was stupid and drowsy. Possibly an examination of the spleen blood would have revealed some development of parasites. There are thus to be seen in Klang 3 non-febrile forms of the crescent series.

Three other forms are also to be seen, and they appear to be stages in the development of the crescent, but their exact relationship is not clear to me, as I have not had an opportunity of watching their development. They are seen only in severe infections.

In the first form the red cell substance has disappeared except for a crescentic part in breadth less than $\frac{1}{4}$ of the red corpuscle. The remainder is clear ; evidently the parasite. In the middle is a group of pigment particles, usually four in number, which move slowly on each other, but always keep together. The remains of the red cell is practically of normal colour.

In the second form the difference from the previous (1) form is that instead of only four particles of pigment, there are twenty or thirty. These particles are actively motile in the clear mass of the parasite and instead of grouping themselves in the centre, stretch themselves out in a way suggestive of a crescent form and then retract into a rod-like mass while watched—the movement of elongation was always in the one direction.

A third and uncommon form (I have only seen it in one case) was when a cell as large as a red cell but perfectly clear, contained a dumb bell shaped body. The ends of the dumb bell were intensely black and they seemed to be connected by a tube-like membrane in which three small pieces of pigment

were lying. One small piece of pigment, apparently separate from the others, was motile slightly, the rest were non-motile. There are three undoubted fever forms, as follows:—

(1) The small unpigmented parasite is common. It is, in diameter, about $\frac{1}{4}$ of the diameter of a red cell, rarely more than a third. It usually occurs in greater numbers than is seen in the most extreme case of Benign infection. Two in one cell are often seen. It is actively motile but at times comes to rest as a circle. It is difficult to see unless focussed exactly. Colour of red cell unaffected.

(2) A similar parasite in every way, except that it has fine pigment, is also to be seen. Colour of red cell affected.

(3) Another form is much more easily seen, as it shows as a clear body in the red cell, however it is focussed. It always has pigment and the pigment is actively motile and eccentric as a rule. In size it is about $\frac{1}{4}$ of the diameter of the red cell. Colour of red cell unaffected. I have only seen this in severe cases of Malaria.

In one case I saw all the nine different forms of Malignant parasite. The case came from Kwala Selangor, and died three hours after admission, on about the 10th day of the illness.

Percentage of the Varieties.

The total number of cases in which I have found parasites is so small that the percentages must only be taken as a general indication. The great majority are hospital cases admitted from about the last week in June to the end of the first fortnight in August. Only very few of the Malarial cases before June were noted, apart from the hospital case sheet, and are not included.

KLANG.

Type.	No. of Cases.	Percentage.
Malignant	28	51·8
Benign Tertian	19	31·18
,, Quartan	4	7·4
Mixed Benign Tertian and Malignant	3	5·5
TOTAL	54	95·88

PORT SWETTENHAM.

Type.	No. of Cases.	Percentage.
Malignant	9	60
Benign Tertian	5	33·3
Mixed Benign Tertian and Malignant	1	6·3
TOTAL.. ..	15	99.6

Curiously enough, two of the Quartans are now in the Hospital, and in adjacent beds. One got his fever in Jugra and the other in Jeram.

As I have also found Malignant and Benign Tertian cases at Jugra, Jeram, and Kwala Selangor, I am in a position to state that I have seen three varieties of parasites in each of the Coast Districts.

Relationship of Parasites to Temperature.

In two Quartan cases I have watched the growth of the parasites, and rosettes have been seen an hour before fever started.

In the Benign Tertian the fever usually begins when the form seen in the peripheral blood has completely filled the enlarged red cell, but when the pigment is still active. Thus the fever would seem to anticipate the breaking down of the rosette body, although possibly rosettes are breaking down in the internal organs.

The Malignant cycle is not clear, but one can distinguish fever and non-fever forms.

Children

That children suffer considerably is very evident, but I have not had an opportunity of making a systematic examination of the blood of a series of children. In two houses the first to be attacked was a child, and only later the parents took fever. In one case the father, mother, and a servant developed fever between the 19th and 21st days after the child's illness. On the other hand, I have seen two children and an adult develope fever, 15, 18 and 26 days after an attack in an adult.

Association with Anopheles

One variety with four spots on its wings is very common here. Males can be caught at any time. Females are seen inside my mosquito net about once a fortnight.

Breeding places are very numerous. I have found them in stagnant pools of all sizes, and practically of any quality of water, even in offensively smelling water.

In a clear pond with a considerable current and with no obvious vegetable growth, a large number was found at Jugra. The sides were clean. This was a well in use.

In Klang in wells used and disused they are to be seen, and large numbers breed in the earth drains running along the roadsides.

In Port Swettenham, I found them in a well and a number of stagnant pools.

THE TREATMENT OF MALARIA

BY

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The treatment of this disease, or, rather, group of diseases, may well be said to consist of the intelligent administration of quinine.

Although the results of treatment are as a rule very satisfactory, I know of no disease, the successful treatment of which so much depends on careful and systematic observation, as Malarial Fever in its various forms.

In the Malay Peninsula we have to deal with practically all forms of the disease, with the exception of that known as Hæmoglobinuric or Black-water fever. The Benign Tertian and Quartan types, as observed locally, do not differ in their clinical history from the same diseases as observed in other parts of the world, but I am inclined to think that the so-called Malignant or Aestivo-Autumnal forms, do not as a rule present the acute and dangerous symptoms so common in Tropical Africa.

Although it is not uncommon for patients to be brought into hospital in a comatose condition, with their blood swarming with Malignant parasites, it is almost invariably found in such cases that the fever has been of some considerable duration, and that no attempt has been made to combat it by the use of quinine.

It is probable that nearly all these cases could be cured by early and intelligent treatment, and it is hoped that, as the use of quinine is more fully realised by the various Asiatic races, results will be even more satisfactory than they are at present.

Before any attempt is made to treat a case of Malarial fever, the blood should, if possible, be examined under the microscope. A few minutes' careful inspection of the fresh unstained blood will often be enough, but should no parasites be found, it is advisable to stain a dried film, and search for young amœbula or small hyaline Malignant parasites, which having escaped observation in the fresh blood, will become evident in the stained specimen.

A diagnosis having been made in this way, treatment can be carried out with confidence, and with an intelligent idea as to the probable result, such as can never be attained without blood examination.

In order to give an idea of the broad principles of the treatment of Malaria, before dealing with modifications necessary in connection with the severer forms of the disease, it is proposed to first describe the general details of treatment of the Benign Tertian and Quartan fevers.

Treatment of the Benign Types of Malaria.

The first thing to be done in all cases of Malarial fever is to put the patient to bed. This may be considered as second only in importance to the administration of quinine, and should always be insisted on. The majority of Europeans who are admitted to hospital with Malaria, are either planters or officers whose work takes them into the country districts, and is of an active nature. As a rule, when suffering from fever, they make every effort to carry on their ordinary routine of daily work between the attacks. They fully realise the value of quinine as a remedy and usually take large doses with regularity. In spite of this, however, the fever constantly recurs, and the patient comes to hospital very much weakened by repeated attacks. When put to bed, on a suitable diet, quinine acts like a charm, and it is seldom that the temperature rises, even after the first dose. In a tropical climate there is no doubt but that active bodily exercise causes the excretion of quinine from the body at an extraordinary rapid rate, and I believe that to this fact may be ascribed the comparatively disappointing results of the regular administration of quinine as a prophylactic against Malarial fevers. As a routine practice it is well to give a purgative before commencing treatment by quinine. A favourite form of purgative is five grains of calomel, followed in about eight hours by a saline effervescent draught.

In order to secure the most favourable effect of quinine, the following points should be considered in connection with its administration :—

(1) The best form to use, and the means by which it should be introduced into the system.

(2) The most suitable dose.

(3) The time in relation to the attack of pyrexia at which quinine may most advantageously be given.

(1) The salt almost invariably used is the sulphate. It should when possible be given in solution by the mouth. Dilute Sulphuric or Hydrobromic acid are most frequently used as solvents.

A favourite method of taking quinine in the Malay Peninsula, is by rolling up about five grains of the sulphate in a cigarette paper, and swallowing it like a large pill. The objection to this method is, that the rate of absorption of the drug depends to a large extent on the condition and amount of gastric juice in the stomach at the time; its effects are, therefore, not so regular and reliable as when taken in solution.

Tabloids and sugar coated pills cannot be recommended; they are apt to become hardened and discoloured, and not infrequently pass through the body practically unchanged.

(2) The dose varies between five and twenty grains. The usual dose in an ordinary Benign case is ten grains, taken morning and evening for four or five days, followed by one dose daily of ten grains for about a week. The amount may then be reduced to five grains daily for another week; after this an occasional dose of ten grains should be taken about once a week. As long as the patient resides in a Malarial district, a dose of ten grains should be taken at least twice a week.

In neglected cases, or when there is much constitutional disturbance, the first few doses are usually larger, but rarely exceed fifteen grains.

(3) In the Benign fevers quinine may be given either two or three hours before an attack of pyrexia is expected, or so soon after an attack as free sweating has reduced the temperature.

The latter period is the one usually selected. There is no doubt that in a considerable number of cases, an attack of fever has been aborted by quinine given a few hours before the attack. This is well illustrated by the accompanying charts Nos. 3 and 4.

In Case No. 3, 15 grains of quinine were given at 8 a.m. on the day on which an attack of Quartan fever was expected. The temperature did not rise and remained normal subsequently.

In Case No. 4, the blood was examined immediately before the administration of 10 grains at 8 a.m., an attack of fever being expected at 4 p.m. Numerous full grown parasites and commencing rosettes were observed, but no rise of temperature followed. The blood was examined again at 4 p.m., and only one or two small parasites could be found.

In the case illustrated by Chart No. 2, the quinine failed to abort the attack due the same day, but effectually prevented any subsequent rise of temperature. This is the usual experience. The main objection to giving quinine during pyrexia is the difficulty patients often have retaining it. There is a general idea also that the headache which is usually present during an attack of fever, is increased by the administration of quinine.

In the Benign forms of fever, complications are the exception. Diarrhœa and vomiting are occasionally present, but seldom call for special treatment. Headache may be relieved by phenacetine in ten-grain doses or one of the allied remedies. The application of an icebag to the head is soothing and is often of use in reducing headache.

The administration of quinine by intramuscular or intravenous injection is in my opinion never necessary in either Benign Tertian or Quartan fever, and I have never seen a case in which a satisfactory cure could not be effected by suitable doses of quinine taken by the mouth.

Treatment of Malignant or Aestivo-Autumnal Fever.

As a matter of routine diagnosis as a guide to treatment little or no attempt has been made until lately to divide cases of Malignant fever into the Pigmented and Unpigmented Quotidian or Tertian types.

All crescent-forming fevers are locally termed Malignant both for purposes of classification and treatment.

These cases as a rule give little or no difficulty, and respond to the administration of quinine almost as rapidly and quickly as the Benign fevers. Charts Nos. 5 and 6 are good examples of the rapid action of quinine in Malignant fevers.

In No. 5, a case of Malignant Quotidian, the temperature fell to normal after thirty grains had been given in three ten-grain doses and did not rise again. This man, who was admitted in a very weak state, was kept in hospital for twenty days after his temperature became normal, and was then discharged—his blood being quite free from crescents.

Chart No. 6.—A case of Malignant Tertian: is of interest on account of the very rapid effect of quinine after four days' rest in hospital. This patient was admitted in an extremely weak state, the fever being complicated with dysentery. He was discharged cured after ten days' treatment.

Although in the majority of cases quinine causes the rapid disappearance of parasites from the blood, it is almost invariably found that crescents appear from a few days to a week after the other parasites have been destroyed, quinine apparently having no effect upon them.

Cases of a more serious nature, and demanding more energetic treatment not infrequently occur. It is occasionally found that Malignant fever resists all treatment by quinine when given by the mouth. There is no doubt but that many of these cases are complicated by pneumonia, or some other disease, which is often overlooked. Cases do, however, come under observation which are not complicated in any way, and which are carefully treated from the commencement of the attack, but do not respond to treatment by quinine as ordinarily given. In cases of this kind, in which either a fair trial has been given to quinine by the mouth, or the symptoms are urgent, intramuscular or intravenous injection should be resorted to.

Intramuscular Injection of Quinine.

On account of its solubility, the best form of quinine for intramuscular injection is the bi-hydrochlorate. The hydrobromate is also frequently used. The injection can be made with an ordinary hypodermic syringe, but the greatest care should be taken to ensure that the fluid to be injected, and the syringe itself, have been properly sterilized. In addition to sterilization by heat, it is a good plan to fill the syringe and needle with a 1—20

solution of carbolic acid some time before it is used, emptying it just before the injection is given. I have never seen any inflammation follow an intramuscular injection of quinine when this procedure has been adopted. The usual dose is ten grains, which, in cases when the symptoms are serious, may be increased to fifteen grains. This should be repeated twice or three times daily, until the dangerous symptoms are relieved, when it should at once be stopped, and treatment be continued by the mouth.

The injection may be made into any muscle, the gluteus maximus or triceps for preference, and the needle should be thrust deeply into the muscular tissue, care being taken never to inject quinine subcutaneously, or into the subcutaneous tissue.

Chart No. 7 illustrates a case of Malignant fever cured by intramuscular injection after treatment by the mouth had failed.

The patient was a Tamil dresser, who contracted fever while in charge of a hospital in a well known Malarial centre. He was admitted to hospital ten days after his first attack, during which his temperature rose daily, in spite of his taking full doses of quinine regularly. On admission his temperature was 103° F. and he appeared to be very ill. Blood examination showed a few small non-pigmented parasites, and Malarial pigment in leucocytes. He was at once put to bed, and fifteen grains of quinine given thrice daily in solution by the mouth. No improvement being shown after two days of this treatment, five grains of hydrochlorate of quinine were injected intramuscularly twice daily. After two days the temperature fell to normal, but rose again to 103° F. The intramuscular injections were continued for five days, after which his temperature did not rise above 100° F. He was discharged in good health on June 25th, the temperature having been normal for five days. In this case the doses of quinine were too small, and had ten grains instead of five been injected on each occasion a more rapid result might have been looked for.

Intravenous Injection of Quinine.

This is the most rapid method of introducing quinine into the system, and so securing its immediate effect on Malarial parasites present in the blood. It is suitable for the treatment of cases which come under observation in a comatose condition, or when cerebral symptoms or hyperpyrexia call for prompt action.

The usual dose is ten grains, dissolved in one ounce of normal saline solution. The most convenient vein to select for the injection is one of the branches of the cephalic or basilic at the bend of the elbow.

Great care should be taken, as in the case of intramuscular injection, to see that both syringe and fluid are properly sterilized. The danger of injecting air into the vein should not be forgotten, and care should be taken to see that the needle is in the vein, and not in the subcutaneous tissue.

This method of administration of quinine is strongly advocated by Dr. W. L. BRADDON, State Surgeon of Negri Sembilan, who, in an article on the subject published in the Journal of Tropical Medicine for June 1, 1901, adopts KOCH's description of Malignant fevers as tropical fever, and gives an analysis of 122 cases, in 56 of which quinine was given by the mouth, in 25 by intramuscular injection, and in 41 by intravenous injection.

In each group of cases "the number of days after the beginning of treatment to the disappearance of parasites and clinical signs of fever" is given. The result showed that in no case did the clinical symptoms and parasites disappear within two days of the oral administration of quinine, in seven cases only when the intramuscular method was adopted, but that in thirty-three out of the forty cases in which quinine was given by intravenous injection, the clinical symptoms and parasites disappeared within two days.

Unfortunately, the value of these figures is very much discounted by the fact that Dr. BRADDON gives no details as to the dose of quinine employed either when given by the mouth, intramuscularly or intravenously. No mention is made of the period in relation to the attack of pyrexia which was selected for administration of the drug. It is not stated either whether quinine was given by the mouth in solution or otherwise. The disappearance or otherwise of crescents from the blood is not notified, and as they are not mentioned at all by Dr. BRADDON, it is not clear whether he intends to include them under parasites or not.

Dr. BRADDON states at the conclusion of his article: "In this case the "value of the intravenous use of quinine appeared to be so unmistakable "that I determined to treat all my hospital cases by routine in the same "manner."

The general experience in the Selangor hospitals is that the majority of cases of Malignant Malaria can be simply and effectually treated by oral administration of quinine, and since it cannot be argued that intravenous injection is entirely without risk to the patient, the adoption of this method as routine treatment seems to be unnecessary and unjustifiable.

As the more rapid and less painful method of introducing quinine into the circulation, intravenous injection is perhaps preferable to intramuscular, but there are circumstances under which the intramuscular injection is the more suitable. In the case of young children, where the veins are naturally small, and the patient often restless, the introduction of a hypodermic needle into a vein is a matter of some difficulty, whereas an injection into the gluteal region is easy and effectual.

Again, in the case of a Tamil patient when the case comes under observation at night, and the available light is not of the brighest description, it is by no means an easy matter to successfully penetrate a vein with a hypodermic needle.

It will be seen, therefore, that both methods have their uses, and the selection of one or the other will largely depend upon circumstances.

Complications in Treatment of Malarial Fevers, Diarrhœa and Dysentery.

Either of these diseases not infrequently occur in connection with Malarial attacks. They do not, however, often call for special treatment, and usually disappear under the administration of quinine.

Bilious Vomiting.—This is occasionally a troublesome complication. It may entirely prevent the administration of quinine by the mouth and in such cases a dose of ten grains should be given by intravenous or intramuscular injection.

When the stomach is able to retain fluids, the injections should be stopped, and treatment continued by the mouth. Washing out the stomach by repeated draughts of hot water as recommended by Dr. MANSON is often successful in checking bilious vomiting.

A hypodermic injection of morphia will as a rule have the same effect, and relief is often afforded by sucking small lumps of ice.

Hyperpyrexia.—This most dangerous symptom is not often met with in the Malay Peninsula. For its treatment the intravenous injection of quinine should be supplemented by cold sponging, or packing in ice, and the application of ice to the head. In these cases it is of the greatest importance to prevent cerebral symptoms by reducing the temperature as rapidly as possible, thus giving the quinine time to exert its action on the parasites in the cerebral vessels before fatal damage is done.

Malarial Coma.—Patients are not infrequently brought into hospital in condition of coma, but it is very rare among patients under treatment in the hospitals.

An intravenous injection of 10—15 grains of quinine should be given at once, and from five to ten grains of calomel by the mouth, if the patient will swallow, if not, a copious enema of castor oil will open the bowels. A case having shewn symptoms of coma should be very carefully watched, as it is often apt to recur even without any considerable rise in temperature.

Splenic Enlargement and Tenderness.

This symptom is more frequently met with among natives than Europeans. Tamils are particularly liable to enlargement of the spleen, and in some districts the greater number of Tamil children suffer from it. The enlargement is very chronic, and it is difficult to reduce, the spleen becoming painful and tender with each attack of Malaria.

During the fever, when the spleen is painful, counter-irritation with unguentum hydrarg bin-iodide will, as a rule, give relief. Chronic enlargement may be treated by a mixture containing quinine, iron, arsenic and a saline aperient. This is often very successful in reducing splenic enlargement in young children.

Malarial Cachexia.— Europeans who do not rapidly regain their average health after an attack of Malaria, or who are subject to repeated severe attacks, should be advised to leave the tropics as soon as possible, and to remain in a temperate climate for at least a year. When this is impossible a change to a non-Malarious district should be insisted on.

Of the native races, Chinese and Malays, as a rule, recover quickly and well from Malarial fever, but Tamils after a few comparatively mild attacks very frequently pass into a condition of marked anæmia. Their faces and legs become œdematous, they are unable to digest their food, and in a very short time become totally unfitted for labour of any kind. If left untreated, and under their ordinary conditions of life, they become rapidly weaker and die. If admitted into hospital, and carefully nourished by a liberal diet, consisting mainly of fresh milk and eggs, the majority of these cases recover and eventually regain their normal strength.

The Treatment of Malaria in Children.

Especial mention is made of Malaria in children, on account of the comparatively frequent occurrence of epileptiform convulsions and coma, in connection with apparently simple Malarial attacks. The death-rate from convulsions among children in the Malay Peninsula is very high. The greater number of these cases are only reported after death, but from the almost invariable existence of Malaria in those cases which have come under observation I feel sure that in the majority of cases death is due to that disease.

The infant mortality on some estates where the coolies suffer much from fever is terribly high.

I know of one estate (since abandoned) on which a large Tamil labour force was employed, where *all* the infants died. The manager offered a reward for the first child successfully reared on the estate, but that reward was, I believe, never claimed.

The treatment of Benign Tertian or Quartan fever in children differs in no way from that recommended for adults. Care should, however, be taken not to waste time by giving very small doses of quinine by the mouth. Infants and children take quinine well, and doses of one grain twice or thrice daily may be given to infants under six months old. Two grains twice daily to infants over six months, and three grains twice daily to children over one year old.

Chart No. 2 illustrates a case of Benign Tertian, with a double infection, in a child ten months old, in which a cure was rapidly and successfully effected by the administration by the mouth of three grains of quinine twice daily.

In cases of Malignant fever in young children intramuscular injection of quinine should be resorted to in all but the mildest cases. The amount of quinine to be injected varies according to the age of the patient and the nature of the case.

Chart No. 8 illustrates the case of an Eurasian child, three years of age, who became rapidly unconscious after an attack of Malignant Malaria. She remained in a comatose condition for about twenty-four hours, during which time she had four epileptiform attacks. Five grains of hydrochlorate of quinine were injected into the gluteal region, directly the case came under observation, and three grains eight hours afterwards. The temperature then became normal and remained so for once sixteen hours. It rose again the following day, when three grains were injected, the subsequent treatment being carried out by the mouth.

Small unpigmented parasites were found in the blood shortly after the first convulsion, but they disappeared after the injection of quinine, only one or two being seen on the following day, and none two days after the first injection.

In connection with the theory that Blackwater or Hæmoglobinuric fever is caused by the administration of quinine in large doses, in the treatment of Malarial fever, it may be of interest to note that no case of Blackwater fever has, that I am aware of, ever occurred in the Malay Peninsula, although large numbers of all forms of Malarial fever are being treated daily by full doses of quinine.

INDEX TO CHARTS.

Case I. BENIGN TERTIAN MALARIA. *District Hospital, Klang.*

Patient, a Tamil, aged 18 years. No previous history of Malaria. Fever for ten days before admission. Shews rapid cure of fever by ten-grain doses of quinine by mouth. Admitted July 13th. Discharged July 22nd.

Case II. BENIGN TERTIAN. DOUBLE INFECTION. *District Hospital, Klang.*

A Tamil child, aged 10 months. Had fever for ten days before admission to hospital. Child very restless and weak on admission.

Treatment.—01 Ricini drams 4, and quinine grains 3 thrice daily by mouth. Chart shews one attack of pyrexia after quinine. Admitted August 7th. Discharged August 20th.

Case III. QUARTAN. *District Hospital, Klang.*

Patient, a Malay man, aged 43 years. Had a similar attack of fever eight months before. Temperature normal on admission. Attacks of fever occurred on 11th, 14th, 17th August, commencing regularly at about 4 p.m.

Treatment by 10 grains of quinine twice daily, first dose given at 8 a.m. on 20th August, fever being due at 4 p.m. same day.

Blood examination at 8 a.m. showed numerous full grown parasites.

Blood examination at 11.30 a.m. showed numerous rosettes and parasites with scattered pigment.

Blood examination at 4 p.m. one or two young parasites only. No attack of fever occurred.

This case is of special interest as it illustrates the abortion of an attack of fever by quinine after the formation of rosettes. It is extremely rare for an attack to be cut short in this way. Admitted August 9th. Discharged August 26th.

Case IV. QUARTAN. *District Hospital, Klang.*

Patient, a Malay, 23 years old. Had fever three days before admission. Temperature when admitted on August 9th, 103.6° F. Had an attack on 12th and 15th instant.

Treatment.—Calomel 5 grains on August 10th. Quinine grs. 15 by mouth twice daily, commenced at 8 a.m. on 18th, an attack of fever being expected at 4 p.m. The temperature did not rise then or subsequently.

The blood was not examined on 18th August, but numerous full grown parasites and rosettes were seen in the blood at 4 p.m. on August 15th. Admitted August 9th. Discharged August 26th.

Case V. MALIGNANT QUOTIDIAN. *District Hospital, Klang.*

Patient, a Chinese youth aged 15 years. No previous history of Malaria. On admission Temperature 105° F. Very weak, face œdematous, spleen enlarged, slight Diarrhœa. Fever for five days. A very large number of Malignant parasites in blood.

Treatment.—Quinine grs. 10 by mouth twice daily. Temperature rose once only after first dose. Patient was discharged, cured, on August 13th. Crescents appeared in blood on July 23rd, but had disappeared when patient was discharged. Admitted July 21st. Discharged August 13th.

Case VI. MALIGNANT TERTIAN. *District Hospital, Klang.*

Patient, a Tamil, 55 years of age. Very weak and emaciated on admission. No previous history of fever, but had Dysentery for several days.

Treatment.—10 grains of quinine by mouth twice daily. This case illustrates the rapidity with which quinine often acts on a case of Malignant Malaria after a few days' rest in bed. The blood was free from parasites and crescents when patient was discharged on August 10th. Admitted July 31st. Discharged August 10th.

Case VII. IRREGULAR MALIGNANT. *General Hospital, Kuala Lumpor.*

Patient, a Tamil, aged 40 years. Had fever for ten days before admission on June 6th, during which he had taken quinine regularly by mouth. Blood contained small unpigmented parasites on admission.

Treatment.—Intramuscular injection of quinine grs. 5 twice daily for two days and then once daily. This case illustrates cure by intramuscular injection after failure of treatment by mouth. The dose of quinine used should have been 10 grains to ensure full effect on parasites. Admitted June 6th. Discharged June 26th.

Case VIII. MALIGNANT WITH COMA AND CONVULSIONS.

Patient, an European child, aged four years. No previous fever. Had four epileptiform convulsions in 16 hours and was comatose for 24 hours. Small unpigmented parasites seen in blood when case came under observation.

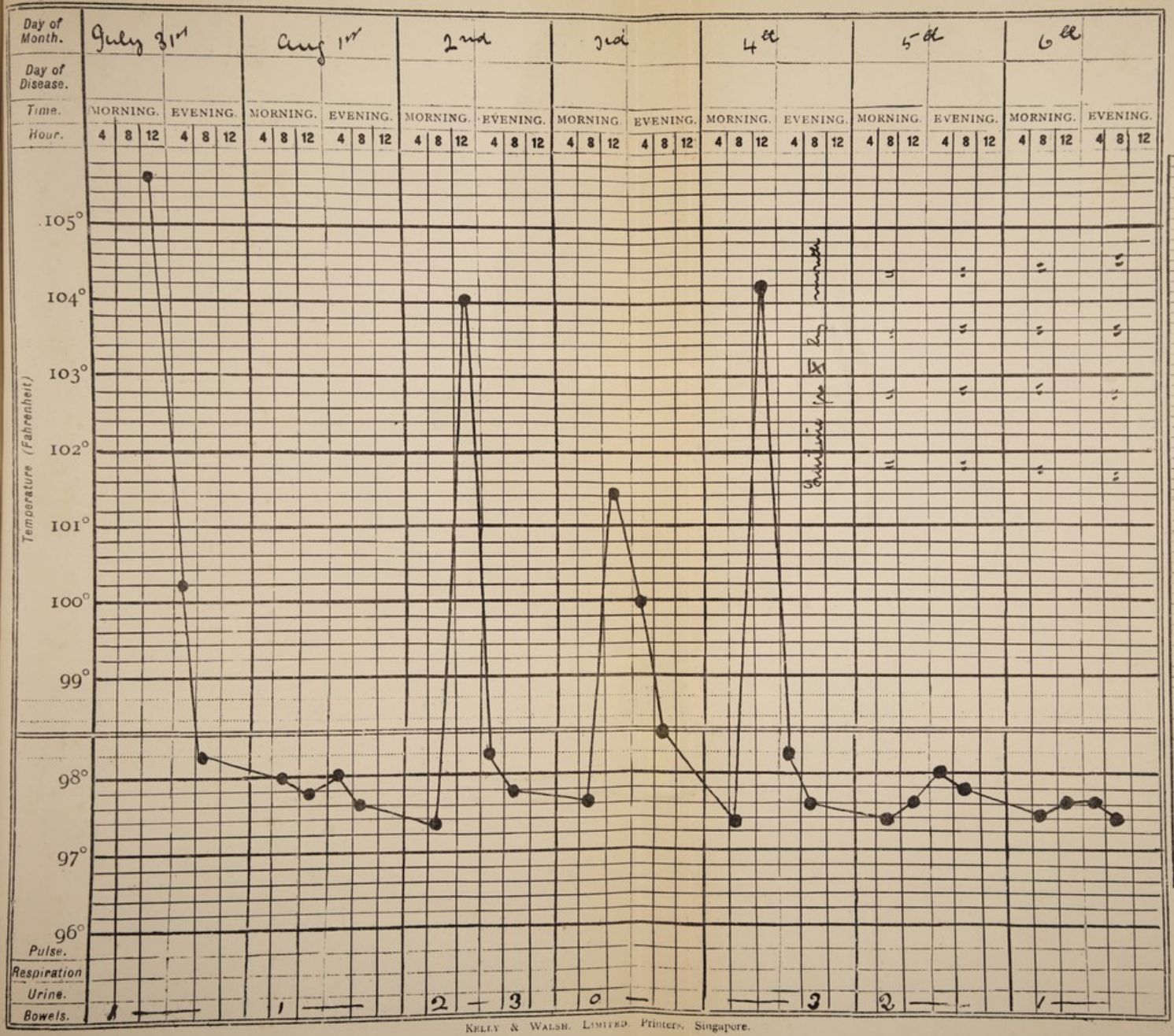
Treatment.—Quinine grs. 5 by intramuscular injection followed by three injections of grs. 3. After three days quinine given by mouth in 3-grain doses twice daily. Treated privately.

Case IX. MIXED MALIGNANT AND BENIGN TERTIAN. *General Hospital, Kuala Lumpor.*

Patient, an Eurasian youth, 17 years of age, had been in same hospital from May 12th to 18th, with Benign Tertian fever; blood showed a double infection. Had fever one day before admission on August 19th. On August 22nd, a large number of half grown Benign Tertian parasites and crescents were found. On August 28th, crescents were plentiful, but no other parasites were present.

Treatment.—Quinine grs. 10 by mouth. Chart shews rapid cure after first dose of quinine. Admitted August 19th. Discharged August 30th.

Case VI.



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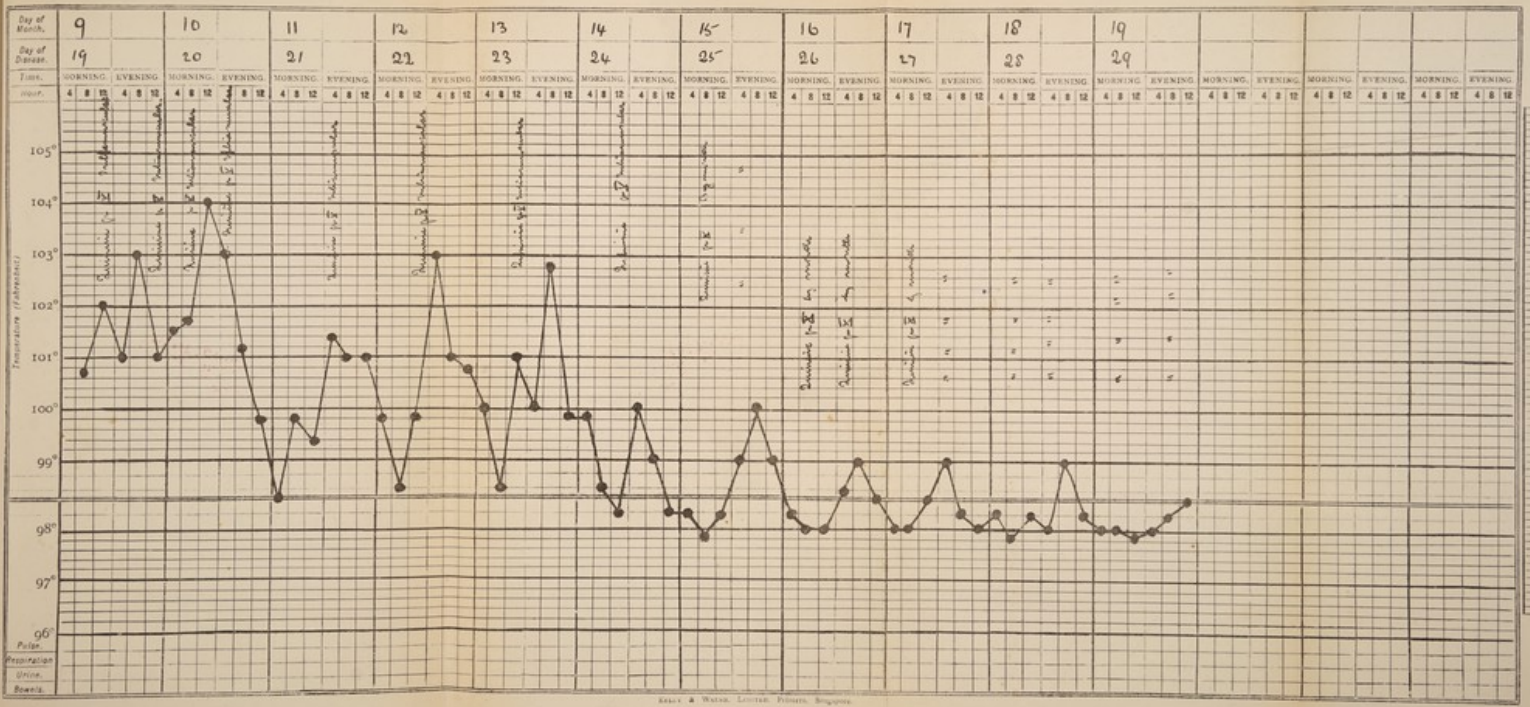

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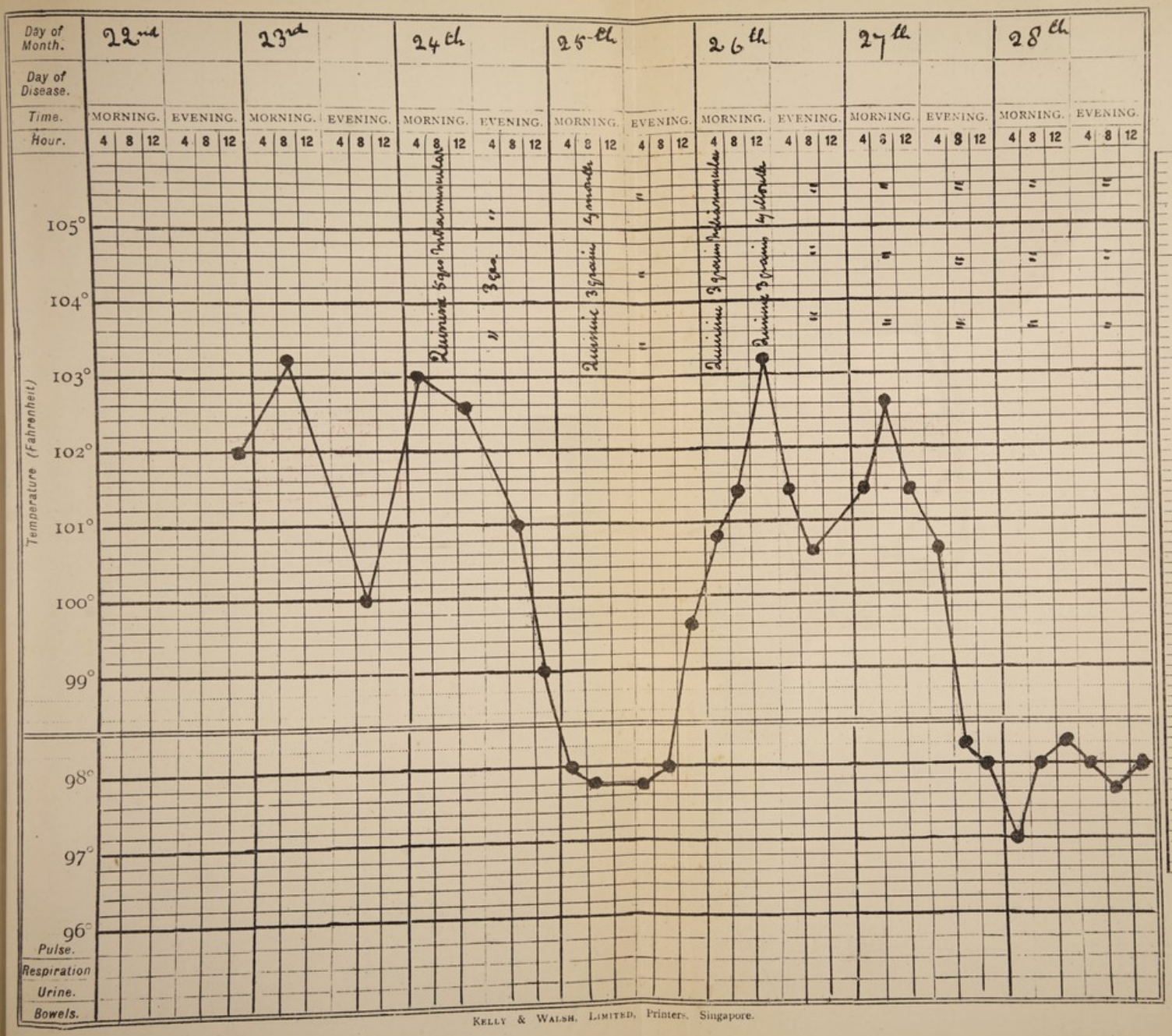

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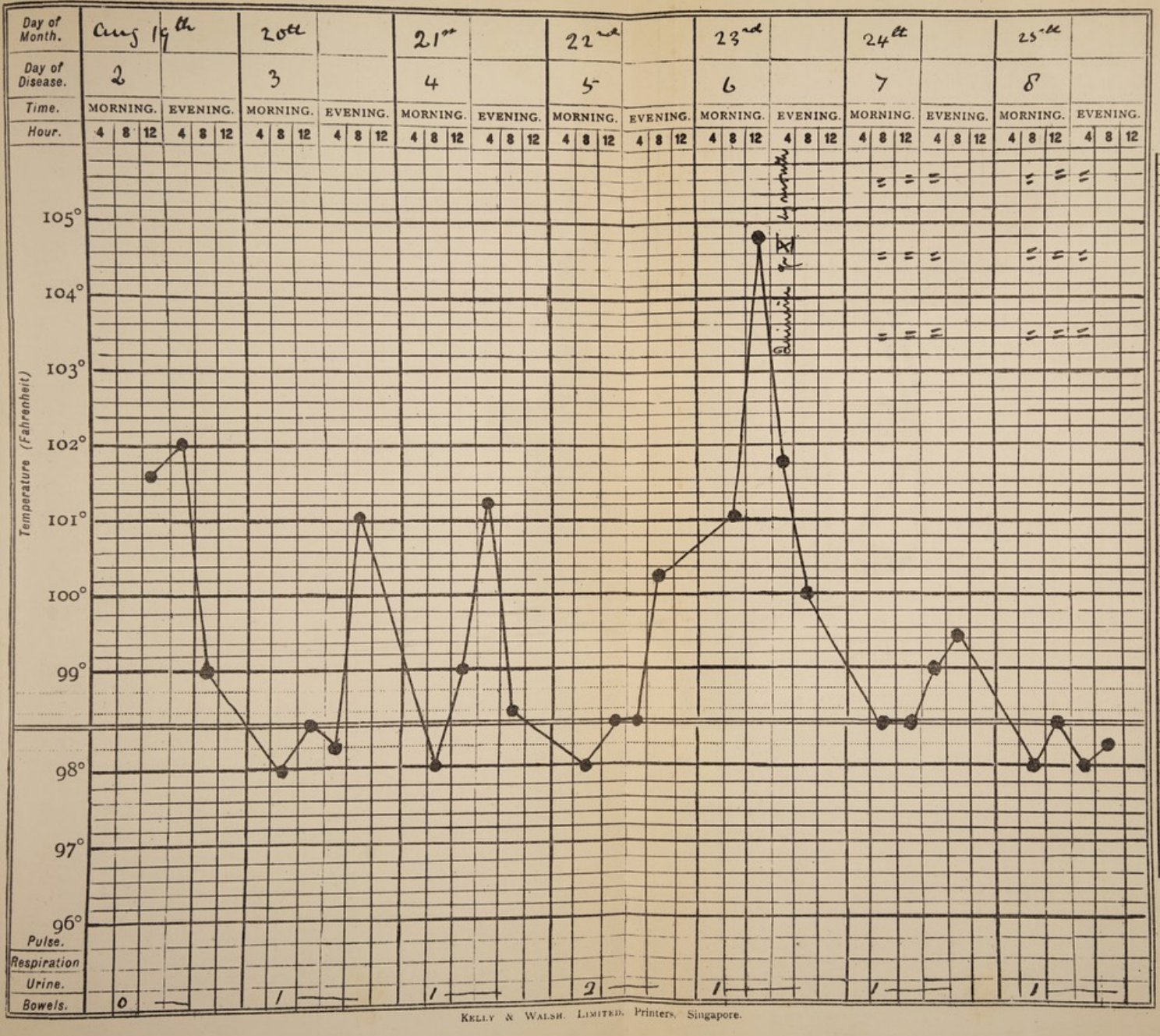
Case IX.



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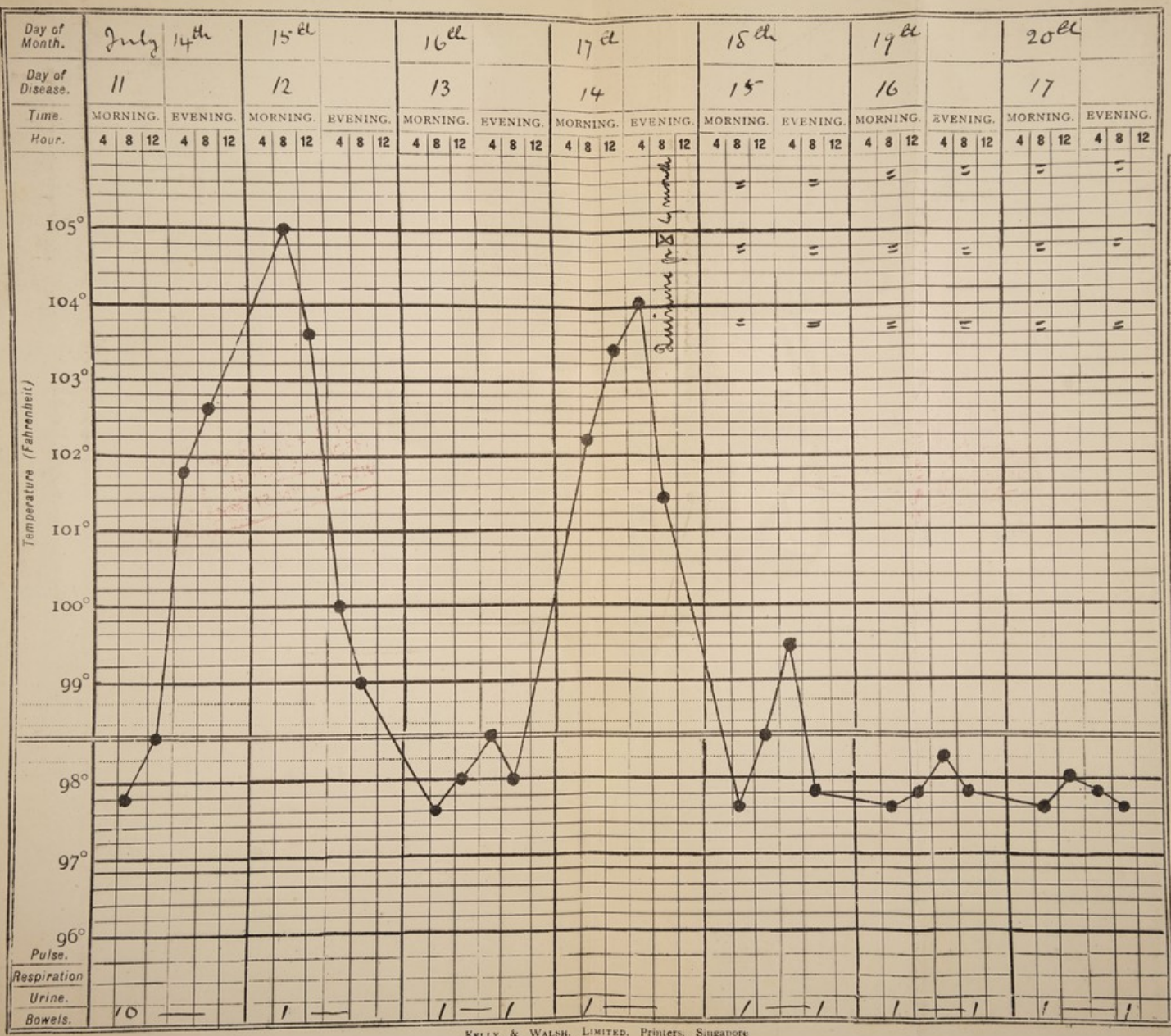

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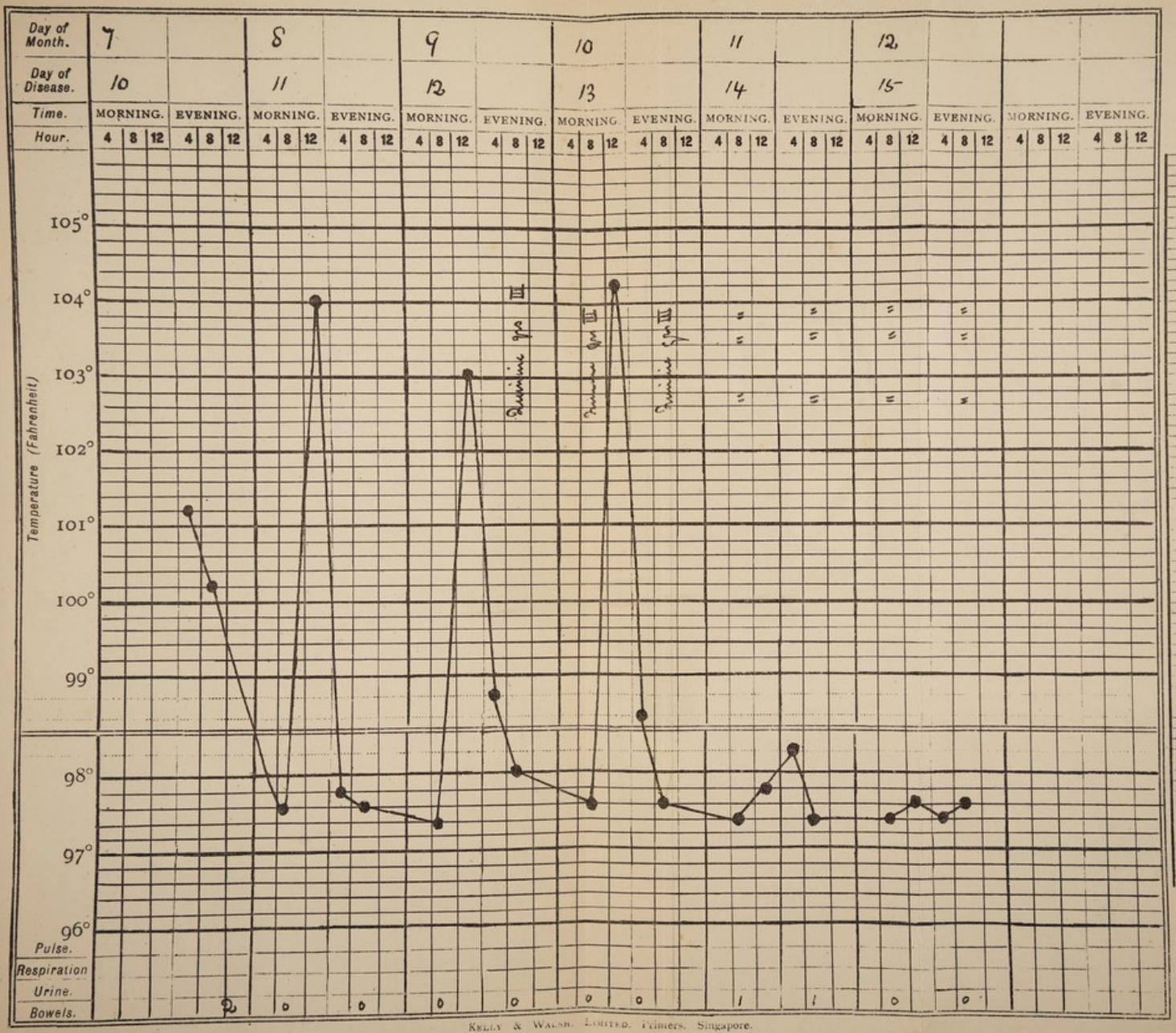
Case II.



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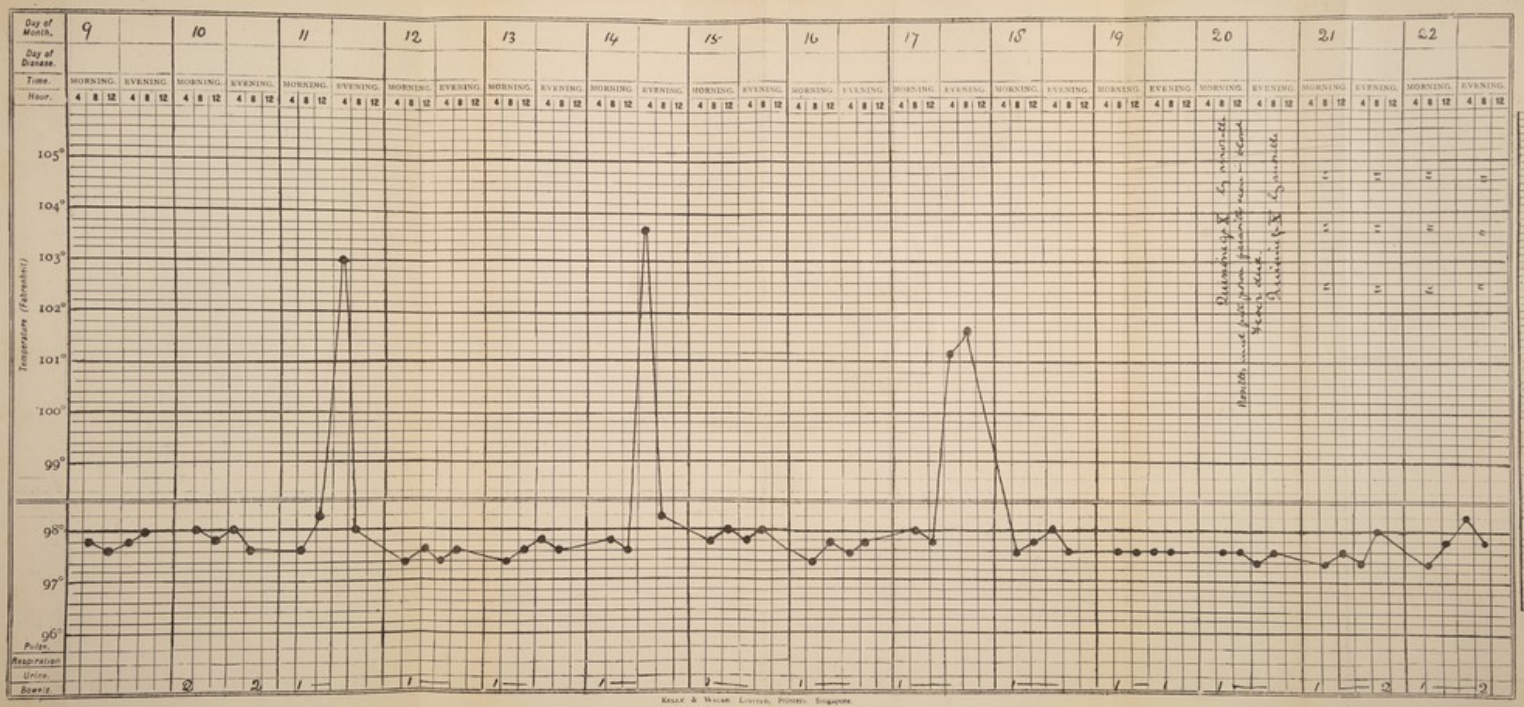

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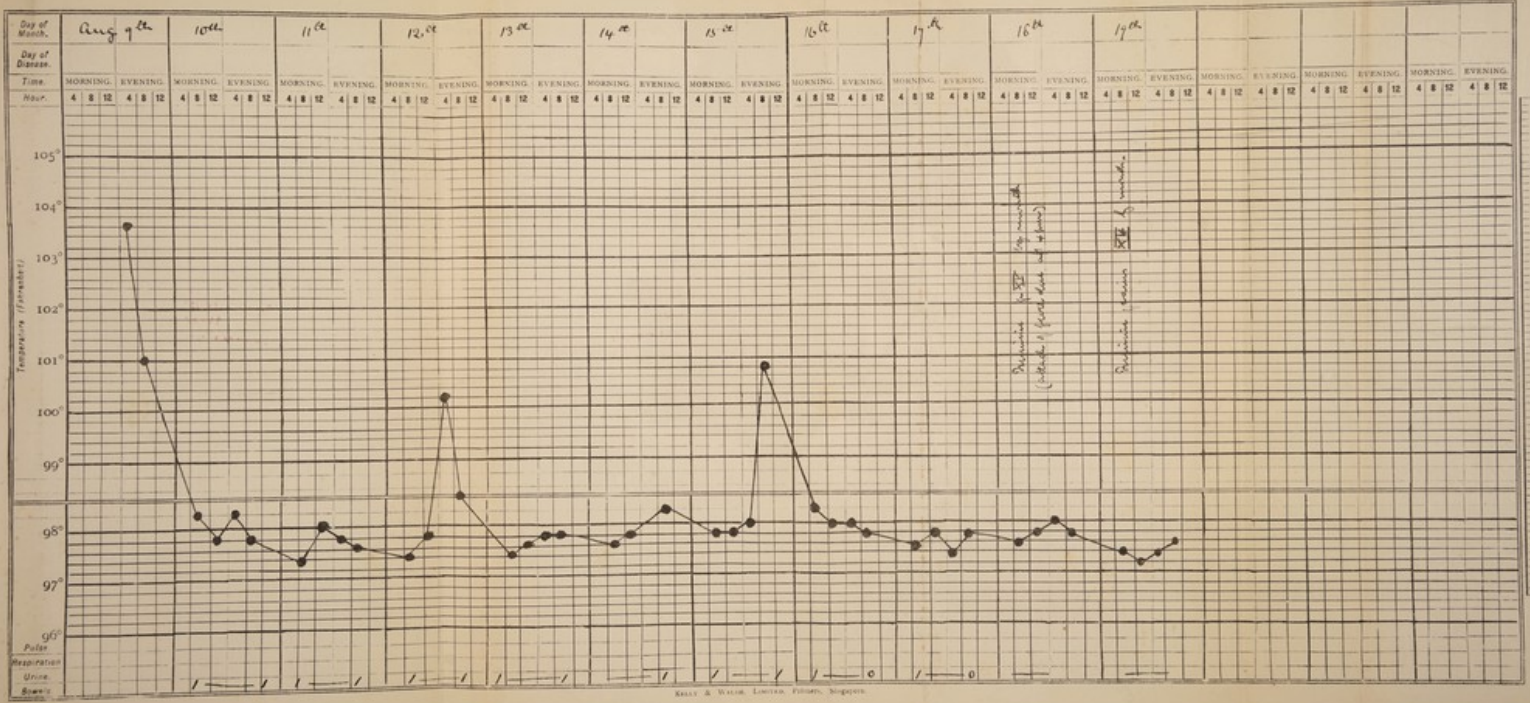

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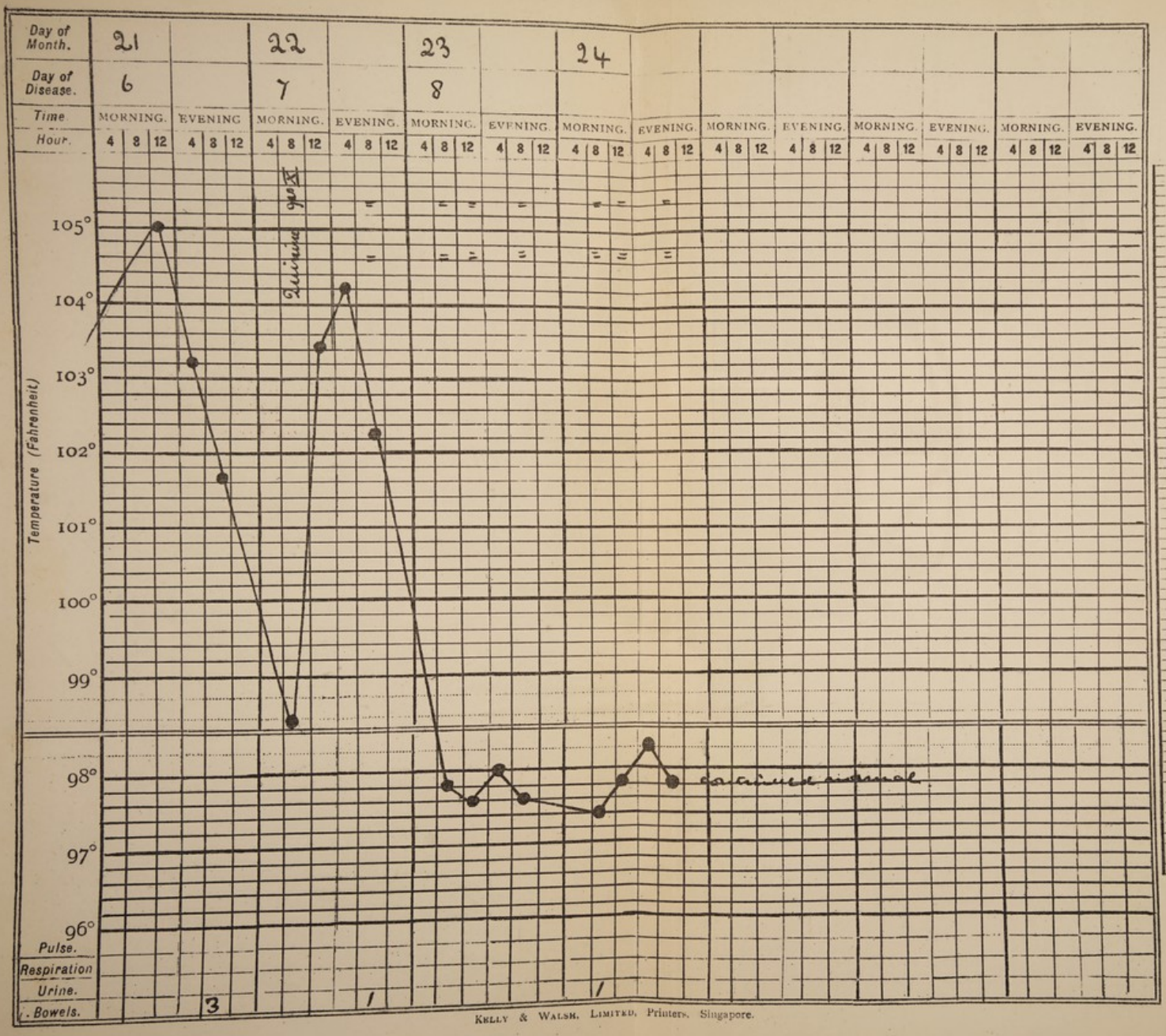

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