Transactions of the malaria conference held at Nagpur in January 1902.

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Malaria Conference (1902 : Nāgpur, India)

Publication/Creation

Nagpur : Printed at the Nagpur Central Jail Press, 1902.

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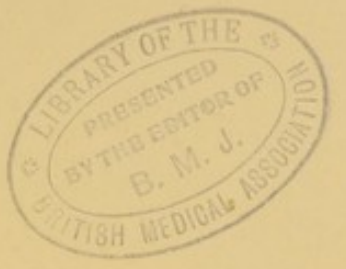
TRANSACTIONS

OF THE

Malaria Conference

HELD AT NAGPUR

IN JANUARY 1902.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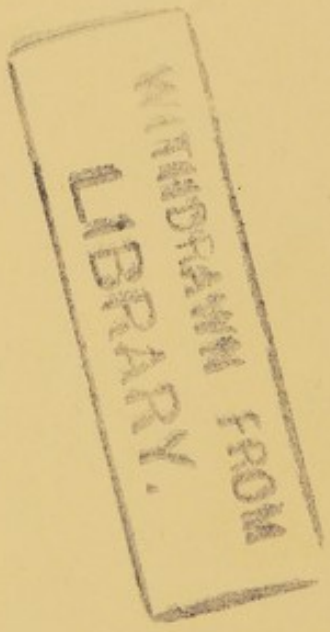
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TRANSACTIONS

OF THE

Malaria Conference

HELD AT

NAGPUR

IN JANUARY 1902.

PRINTED AT THE NAGPUR CENTRAL JAIL PRESS.
1902.

MALARIA CONFERENCE,
NAGPUR.

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COLONEL SCOTT REID, I. M. S., *Administrative Medical Officer, C. P.*

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DR. ARTHUR POWELL.

DR. J. W. W. STEPHENS... *Royal Society's Commissioner.*

MR. E. H. AITKEN.

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No. 1271.

Office of Inspector-General of Civil Hospitals, Punjab.

FROM

COLONEL A. SCOTT REID, I. M. S.,

INSPECTOR-GENERAL OF CIVIL HOSPITALS,

PUNJAB.

(Late Administrative Medical Officer, Central Provinces.)

TO

THE SECOND SECRETARY TO THE

CHIEF COMMISSIONER,

CENTRAL PROVINCES, NAGPUR.

Dated 25th March 1902.

SIR,

With reference to the correspondence ending with Secretariat (General Department) letter No. 484, dated 16th January 1902 to my address, I have the honor to forward for the information of the Hon'ble the Chief Commissioner, Central Provinces, and for favor of transmission to the Government of India, the accompanying Report of the Transactions of a Conference on Malaria, which was held at Nagpur in January 1902.

2. The meetings extended over a period of ten days, and I venture to consider that the following pages bear satisfactory testimony to the amount and nature of the work done—as far as it can be represented on paper—more especially when it is remembered that, from the circumstances under which the Conference was organised, the members received very short notice, and had, therefore, little time in which to prepare papers and subjects for discussion.

3. Section V deals with the "Practical Measures for the prevention of Malaria," and I would suggest that copies of the general rules drawn up by a Sub-Committee appointed for the purpose, and which are embodied in Appendices A., B., C., pages 130–137, should be distributed to the respective authorities and Committees whose interests they concern.

4. Advantage was taken of the meeting together of so many Medical Officers to listen to a most interesting and instructive lecture on "Snake Venoms; their Physiological Action and Antidote," which Captain George Lamb, I. M. S., from the Research Laboratory, Bombay, kindly consented to deliver before a popular audience in the Nagpur Public Hall. His paper appears under Section VII, Miscellaneous.

The subject is of course foreign to the primary object for which the Conference was convened, but as it is one in which I think most people living in India take a keen interest, and in which, moreover, we of the Central Provinces have endeavoured to assist by supplying venomous snakes to the Bombay Laboratory for the purposes of investigation and the preparation of antitoxic serum, an apology for the inclusion of the article in the Transactions seems hardly necessary.

5. My thanks are due to Major Buchanan, I. M. S., who acted as Honorary Secretary to the Conference, for the able manner in which he has edited its Transactions; as also to him and the other Members for their valuable contributions to Science and Practical Sanitation.

I have the honor to be,

SIR,

Your most obedient servant,

A. SCOTT REID, COLONEL, I. M. S.

SECTION I.

PRESIDENT'S ADDRESS.

BY

COLONEL A. SCOTT REID, I. M. S.,

Administrative Medical Officer, Central Provinces.

MR. FRASER*, LADIES AND GENTLEMEN,—

In opening this Conference, my first and pleasantest duty is to thank you all for your presence on the occasion, and to offer, in the name of the Medical Staff of the Central Provinces, and, I think the Honourable the Chief Commissioner will allow me to add, in that of the Administration, a cordial welcome to the Royal Society Malaria Commissioners and those officers who have done us the honour of coming from other and distant Provinces to confer with, and help us in the work we are now undertaking.

Nearly three months ago, I received a letter from the Administration of the Central Provinces, forwarding a copy of another from the Government of India, in which were set forth details of measures which had been commenced in Madras, with a view to the prevention of Malaria, and calling on me for suggestions as to what action should be taken, in these Provinces, on similar lines. As I have no doubt you are all aware, Major Buchanan of the Indian Medical Service had been working at the subject of Malaria for upwards of a year, and had, by this time, not only made himself well acquainted with the progress attained by others in the same direction, but had also added considerably to the stock of knowledge previously available by personal investigations and observations, the results of which he has since embodied in a small but valuable book recently published. He had further equipped an excellent laboratory for the purpose and trained a number of Burman prisoners to be most efficient observers, and one of whom, a man of remarkable intelligence for his position, is, I understand, to read a paper at one of our meetings on some characteristics of the Malaria parasite noticed for the first time by himself. On talking the matter of the initiation of preventive measures over with Major Buchanan, it occurred to us that, as the Civil Surgeons of the Province were the agents on whom

*The Hon'ble the Chief Commissioner, Central Provinces.

the Administration had mainly to rely for introducing and directing sanitary reforms in their respective districts, the facilities which existed at Nagpur presented, as a first step, a most favourable opportunity for those Medical Officers, who, like myself, had hitherto not had the means at their command, of practically studying the subject of Malaria in all its bearings, but especially in connection with what is known as the "Mosquito theory," and with the outlines, at least, of which I presume you are all more or less familiar.

I accordingly addressed the Honourable the Chief Commissioner on the subject, suggesting that Civil Surgeons should be invited to come to Nagpur in parties of three or four at a time, for a course of practical work under the guidance of Major Buchanan, who had generously placed his laboratory at our disposal and offered the use of his own services for the purpose. The knowledge thus acquired would, in my opinion, not only lay the foundation for the evolution of any practical measures for the prevention of Malaria, which might subsequently be formulated, but would also tend to the earlier and more accurate diagnosis of its resultant diseases as well as to their more appropriate treatment. To these proposals I need hardly say that Mr. Fraser, with his usual kindness and sympathy with any measures intended for the welfare of the people over whom he has been placed in charge, promptly assented. On the Government of India coming to know of the efforts we were making to carry out their wishes, they telegraphed to the Administration, suggesting that Local Governments might be asked to be good enough to permit one or two selected Medical Officers from each province to join the Royal Society Commissioners, who were then pursuing their researches here, and ourselves in prosecuting the desired object—a suggestion which we were only too glad to act on, and the results of which have exceeded our most sanguine expectations.

In such manner, Ladies and Gentlemen, have been the inception and evolution of the Nagpur Conference on Malaria. To Major Buchanan is due the credit of having created the facilities for such a course of study and research as we propose to follow, and without which facilities the Conference would have been impossible.

The work before us may be broadly divided into two parts—one the scientific and the other the utilitarian, the objects in the former

being to make ourselves practically familiar with already recorded phenomena and the methods of observing them, to, if possible, settle some disputed points and perchance to wander in new fields of investigation and by untrodden paths. The unexplored mines of knowledge in the realms of nature are infinite, and he would be a bold man who ventured to say that he had nothing further to learn even in regard to a subject of which he had made a special and prolonged study. In the presence, however, of so many experts, for I make no pretence of including myself in that category, I must confess that I feel considerable diffidence in offering further remarks on the scientific side of the subject, and it is only in consideration of the fact that there are possibly among my audience some who have not yet attained even the scanty knowledge which I myself possess, that it may perhaps be permissible in me to attempt to give a brief sketch of the origin and progress of the so-called "Mosquito Theory of Malaria."

Prior to 1880, the class of fevers designated as Malarial, Marsh or Paludal were generally considered (for I think the theories that they were solely due to chills, as stated by Oldham, or the result of insufficient nutrition as affirmed by Lyons, never gained more than a very limited acceptance) to be primarily caused by a product, probably gaseous as the term Malaria implies, generated, in some unexplained way, by the decomposition of vegetable matter under the combined action of heat and moisture and which found its way into the system through the respiratory or digestive tracts, or both together. This was the doctrine which was taught when I entered the Service, and certainly some of the conditions under which these affections usually arose, strongly supported the view, although there were other circumstances which could not readily be accounted for.

However, about 21 years ago, Laveran, a French Military Surgeon, who had been prosecuting researches in Algeria, discovered in the blood of persons suffering from Malaria, numbers of unfamiliar bodies, subsequently called after him, which proved to be unicellular organisms consisting of undifferentiated protoplasm and belonging to the lowest order of the animal kingdom, the Protozoa. These minute creatures, which require to be magnified several hundred times before they come within our visual ken, were further observed, at one stage

of their development, to occupy the red blood corpuscles, upon which they fed and which they destroyed, thus establishing their character as parasites and suggesting their connection with Malaria in the relation of cause to effect. Laveran's discovery was immediately confirmed by Danilewsky, Koch and Dionisi, while the life-history and structure of these organisms in man, and of similar ones in other vertebrate hosts, were followed up by Golgi, Romanowsky, McCallum and other observers.

Here then at last appeared to be the long-sought-for entity of Malaria.

New ideas, however, take a long time to sink into the public mind, and I am old enough to remember, as a student in the Edinburgh University, the incredulity and even ridicule with which the germ theory of putrefaction and the septic infection of wounds was received by some when first enunciated by Lister, and I have a distinct recollection of how one of our revered Professors, a distinguished Surgeon, used to ask one of us after we had entered a ward, to carefully close the door in order to keep out the "Gurrms," as he called them. We of course, as in duty bound, applauded the wit of the joke as often as it was repeated. This spirit of scepticism in scientific matters, although it may delay the acceptance of demonstrated truths for a time, is not an unmixed evil, for it tends to promote greater care and accuracy in observation with closer reasoning in forming inductive or deductive conclusions. The scientist knows that a fierce light of criticism will beat upon any alleged facts and views which he may see fit to announce to the World of Science, and that, before these are accepted, he must show sound grounds for the faith that is in him. Laveran's discovery, although readily acknowledged by men competent to repeat and confirm his observations, was rejected by others, who had hardly a claim to be included in this category, and one of whom went so far as to denounce the Laveran bodies as nothing more or less than altered blood corpuscles.

The next advance was made by Golgi in 1885, when he ascertained that the human parasites propagate within the body of the host by means of ordinary asexual spore-formation, that is, an apparently

spontaneous fission or breaking up of the parent substance, each portion of which then develops into a new individual; and that the exacerbations of fever are coincident with this process, the suggestion being that a toxin or poison, secreted by the parasite, is set free in the act of disruption and finds its way to the heat centres of the nervous system. The fact also accounted for the persistent and indefinite recurrence of attacks after, as in many instances, the patient had left the Malarial area and was no longer exposed to re-infection from the yet undiscovered ex-corporeal source.

So far, the sequence of events seemed simple enough, but there still remained a missing link, and that of the greatest importance, without which our knowledge was incomplete. The question was, where did the parasite come from and how did it effect an entrance into the human blood ? We had no longer a gaseous substance to deal with, as was at first supposed, which could be wafted about by every breeze that blew and absorbed into the system through the medium of air or water, but a solid living organism, part of whose existence must necessarily be passed outside the body. It is true that Malarial fever can be communicated from an infected to an uninfected person by transfusion of their blood, but this channel is obviously out of the question except as an experimental measure.

I need not relate how one line of enquiry after another occurred to, and was followed by, investigators, or how each in turn was rejected as failing to afford a solution of the problem. Suffice it to say that the matter remained "*in statu quo*" until 1894, when the key to the puzzle was indicated by Doctor Patrick Manson.

I have already alluded to the manner in which the Malaria parasite is propagated in the blood by a process of asexual spore-formation, but it had also been observed that a number of the organisms did not undergo this transformation, but changed into other forms named "Gametocytes," and that some of the latter emitted long mobile filaments called "Flagella," which, after struggling for a short time, were seen to break off from the parent cell and dart away among the blood corpuscles, leaving the residue of the Gametocyte an inert and apparently dead mass. This phenomenon, which has hitherto been held to take place

only after the blood has been abstracted from the host, although the point is not yet definitely settled, can be seen by any of you in Major Buchanan's laboratory, as also the attacks on the Flagella bodies by the " Phagocytes " or scavengers of the blood, whose services save us from many an illness. The spectacle is a most interesting one and well worth a visit to the Central Jail, although I must warn you to be prepared to remain a considerable time within its precincts, for I find by experience that, once in Major Buchanan's clutches, it is rather difficult to get away from them, and that, if not careful, he will have your blood before you know what you are about, especially if you display any signs or symptoms of indisposition.

Well, to return to our detached Flagella or "Microgametes" as they are called, whom we left gaily "trekking" off on their own account, I need hardly say that such an extraordinary phenomenon excited the liveliest interest and gave rise to a hot controversy regarding their nature and function, some, among whom was Laveran himself, maintaining that the mobile filaments were living organisms and constituted a stage in the history of the parasite, while others affirmed that the phenomenon was a retrogressive one representing the disintegration and death of the parasite. Should the former theory be correct, the next step to ascertain was where this further stage in the history and development of the organism took place, and already several circumstances existed which helped to point the enquiry in the right direction.

It was known that some parasites require more than one host in which to complete their life-history, and, working on this principle, Manson had some time before discovered, that another tropical disease, "Filariasis," was propagated through the medium of the mosquito, which, in the act of sucking, abstracts the young Filaria, a small worm-like parasite, from an infected person, the definitive host, and sets it free in water, through which medium it was believed to gain access to the human body.* Reasoning from analogy, it was not difficult to suppose that the mosquito or some other suctorial insect might, in the same or a similar manner, act as an intermediate host for the Malaria parasite, affording it a nidus for development and supplying the missing link for the transmission of Malaria from man to man.

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* Dr. Low subsequently showed that the filariæ are most probably conveyed by the proboscis of the mosquito.

Again, to hark back to our Flagella, whom, as I have said, we left gaily "trekking" off among the blood corpuscles, what was their motive and what their purpose? It is the old, old story which has come down to us through the centuries from the Garden of Eden. The newly-born Flagella had felt the first promptings of the tender passion and were rushing off to seek their affinities.

Till now, I have only alluded to one form of Gametocyte, which extrudes Flagella or Microgametes, the latter finally proving to be the male element. Concurrently, however, with the process I have attempted to describe, another Gametocyte is found which produces a Gamete, or Macro-gamete as it is called, which belongs to the fair sex, and it is by the marriage or union of these, the Microgametes and the Macrogametes, that the race, in this method of propagation, is continued. It can, however, readily be understood that the general blood-stream, with its turbulent current and with its possibly inquisitive and gossiping corpuscles, does not present a perfect Eden, in which to pursue the course of true love. Like their betters, the Gametes require a secluded corner or "*kala-jagah*"* for whispering their soft nothings to each other, and this, as I shall show, they find in the stomach-cavity of the mosquito. Although it is true that the initial stages of the courtship are frequently seen, under the microscope, in the blood soon after it is withdrawn from the body, the general opinion held is that this is an accidental anticipation of what usually takes place in the mosquito, due probably to the youthful impatience of the lovers.

It was reserved for Major Ross, who, I am proud to say, belonged to the Indian Medical Service, to trace and demonstrate the further fortunes of the Gametes. Manson communicated his theory to Ross at the end of 1894, and the latter began his investigations at Secunderabad in April 1895. The results are graphically told by himself in an abstract of a discourse delivered before the Royal Institution of Great Britain, and it is from this publication that I take the following particulars. It would be trespassing too much on your time and exhausting your patience to reproduce all the details.

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*A dark place.

Ross was, like Columbus, starting on a voyage of discovery, over an unknown ocean, but without a star or compass to guide him, beyond a theory formed by an inductive process of reasoning from certain data. He tells us of the difficulties he met with and overcame, and how, for nearly two years and a half, the results of his labours were almost entirely negative. At that time, he was no entomologist, and could not obtain even the correct scientific names of the mosquitoes, or gnats as he prefers to call them, with which he was experimenting, and had to invent ones of his own, calling them "grey" and "brindled" from their general appearance. But still Ross worked on.

One of the false scents on which he started was that of using gnats of the genus Culex, which are now known not to be Malaria-carrying mosquitoes, but he had some reason for this line of investigation, for the Culices were acknowledged to be agents in the transmission of Filariæ, to which I have alluded. These mosquitoes he carefully dissected and examined in every possible way and under every condition he could think of, but with nugatory results. He examined some found in notoriously malarious places, and others fed on living parasites, but not one surviving organism could he find in their tissues.

At last, success crowned Ross's efforts, but I will tell the story in his own words. He says:—" In a collecting bottle full of larvæ, "brought by a native from an unknown source, I found a number of "newly-hatched mosquitoes like those first observed by me in the "Sigur Ghat, namely, mosquitoes with spotted wings and boat-shaped "eggs. Eight of these were fed on a patient whose blood contained "crescentic Gametocytes. Unfortunately, I dissected six of them either "prematurely or otherwise unsatisfactorily. The seventh was examined "on August 20th, 1897, cell by cell. The tissues of the stomach "(which was now empty, owing to the meal of malarial blood taken "by the insect four days previously being digested) were reserved to, "the last. On turning to this organ, I was struck by observing "scattered on its outer surface, certain oval or round cells of about "two or three times the diameter of a red blood corpuscle-cell which I "had never before seen in any of the hundreds of mosquitoes examined "by me. My surprise was complete when I next detected, within each "of these cells, a few granules of the characteristic coal-black melanin "of malarial fever, a substance quite unlike anything usually found in

"mosquitoes. Next day, the last of the remaining spotted-winged "mosquitoes was dissected. It contained precisely similar cells, "each of which possessed the same melanin ; only the cells in the "second mosquito were somewhat larger than those in the first.

"These fortunate observations practically solved the malaria "problem. As a matter of fact, the cells were the zygotes of the "parasite of remittent fever, growing in the tissues of the gnat ; and "the gnat with spotted wings and boat-shaped eggs in which I had "found them, belonged (as I subsequently ascertained) to the genus "Anopheles."

Before dismissing this part of my subject, I may as well describe, in as few and simple words as I can, what takes place in the mosquito and how it supplies the missing link in the chain of phenomena of the Malaria parasite.

As I have said, the union between the Microgamete and the Macrogamete usually takes place in the digestive tract of the female anopheles, into which they are, with the other constituents of the infected blood, drawn through the insect's proboscis in the act of sucking. After the Macrogamete has been fertilised in this manner, the next thing we find is that it undergoes modifications, becoming what is called a Zygote, the body which Ross tells us he first found on the outer surface of the stomach of the seventh anopheles mosquito he had dissected and which had attained this position by freeing itself from the mass of blood contained in the organ and penetrating the three layers of which its wall consists, the journey occupying about thirty-six hours. In this position it remains quiescent, but begins to grow rapidly until, at the end of six days, or longer according to temperature, it attains about eight times its original size. Meanwhile, important changes take place in the structure of the Zygote. It acquires a thickened capsule and its substance becomes divided into what are called "meres," each of which next becomes a "blastophore" carrying a number of "blasts" attached to its surface. Finally, as described by Ross, the blastophore vanishes, leaving the thick capsule of the Zygote packed with thousands of the blasts or "sporozoites" as they are called by others—minute spindle-shaped organisms.

The capsule of the Zygote now ruptures, allowing the blasts to escape into the body fluids of the mosquito, through which they subsequently find their way into the salivary glands of the insect, where they may be found collected in great numbers. As we are painfully aware from experience, the mosquito, when she bites, injects through the hollow proboscis, with which the excretory ducts of the salivary glands communicate, a quantity of viscid acrid saliva, the purpose of which was formerly unknown and which was popularly attributed to pure "cussedness." It seems now, however, that the object of this fluid is to lubricate the suction apparatus and to prevent the blood clotting in its delicate tube, although I do not see why it should possess an irritant quality, unless for the further purpose of stimulating the circulation at the seat of puncture.

It is with this injection of mosquito saliva that the blasts or young parasites find their entrance into the circulation of man, and, here, with our present knowledge, ends the story, for the organism now disappears from view possibly into the bone-marrow and some of the internal organs, such as the spleen. Nothing further of its history has been ascertained until, after a period of incubation, lasting from twelve to twenty-five days, it is found, with the onset of an attack of fever, in the red blood corpuscles in the forms with which we started. That it has meanwhile undergone an enormous multiplication, there can be no doubt, for the number of blasts introduced by the mosquito would account for but a small proportion of the myriads of parasitic organisms which, when again seen, occupy the red blood corpuscles.

Next we have to deal with the utilitarian or practical side of the question ; for, however interesting scientific researches may be to those conducting them, it is to the practical results of their labours in the form of suggestions and recommendations regarding measures for the prevention or diminution of Malaria that Government and the public look. That the matter is one of vital importance hardly needs demonstration, but I may mention that, during the year 1900, when the full effects of the last famine were experienced, although small-pox and cholera raged in every district of the Central Provinces, the combined mortality arising from these two diseases amounted to only a quarter of that caused by malarial fevers, and that the latter

accounted for half of the aggregate number of deaths from all causes. Still, I think I am correct in saying that the prevalence of small-pox and cholera gave rise to a much greater measure of alarm and panic than did that of malarial fevers. And why? Because, in the first place, the case mortality or proportion of deaths to attacks in the former diseases is greater; and, in the second, because, until now, malaria has not been considered to be communicable, and therefore the moral effect, which the fact of its presence produces on the individual, is not so marked.

Hitherto, reliance has mainly been placed on the use of quinine as a curative and protective agent against malaria, and in this light Government has, throughout India, distributed the drug to all Post Offices, where it can be purchased at a trifle over the cost of production, *viz.*, at 2 pies per dose of 5 grains. In the Central Provinces, we have further lately extended the sale through the agency of schoolmasters and stamp-vendors in places where no Post Offices exist, and, as an experimental measure, in one selected district, also through Patwaris.*

It however behoves those who are held responsible, as far as in them lies, for the amelioration of the general health of the people, to take advantage of any new discoveries made regarding the causation and prevention of disease, and with this object in view, we hope, before the Conference is dissolved, to be able to frame some simple and practicable measures which, if followed, may produce an appreciable improvement in the public health as far as Malaria is concerned. It is here, however, where the difficulty lies; for, to have any chance of success, such measures must meet with the support and co-operation of those in whose interest they are initiated. The undertaking, on anything like an extensive scale, is a formidable one, and therefore I think that it would be well to begin with small and selected areas. The operations in these, if the measures met with marked success, might serve as object lessons for the rest of the Province and tend to promote faith in their efficacy. This is the plan which has been tried on the west coast of Africa, and I have just read Major Ross's first Progress Report of the campaign against mosquitoes in Sierra Leone, which had been conducted by an expedition sent out under the

* Land surveyors.

auspices of the Liverpool School of Tropical Medicine, and in which he says the results were most encouraging. Two or three members of this Conference are, I understand, to read papers at one of our meetings on the subject, giving the details of measures which have been carried out in different parts of India, under their own supervision, and, I hope, with equally satisfactory results.

But, Ladies and Gentlemen, there is a further, and, to my mind, important purpose which such a gathering as this serves.

I doubt if there is a branch of the public service in India the members of which lead more secluded lives, as far as their profession is concerned, than do those of the Indian Medical Service. Most of us, whether in Military or Civil employ, are solitary units—one working alone in a regiment, another in a small and remote Civil Station, and perchance a third in a Central Jail. For us there are no Staff Colleges, Musketry or Garrison Classes, or so-called social "weeks," where we can meet others of our kind and with common interests and sympathies. This fact has been forcibly impressed on my mind during my inspection tours, when I met Civil Surgeons who had served for years together in this province, not a large one, but who had never seen each other, and whose only opportunities for doing so seemed to lie in the chance of meeting on furlough or in course of transfer. I therefore hold that such a Conference as this fulfils a double function, and I trust that its meetings may not only provide a feast of reason but also tend to promote a flow of soul.

POPULAR LECTURE IN THE PUBLIC ROOMS, NAGPUR, WITH MAGIC LANTERN ILLUSTRATIONS,

BY

MAJOR A. BUCHANAN, I. M. S.

INVESTIGATIONS INTO MALARIA IN INDIA.

I propose this evening to speak of the germs or Parasites of Malaria, and the fevers that are caused by them, and more particularly of the investigations, observations and discoveries that we have made here in Nagpur during the past year.

If you were down at our small Laboratory in the Jail I could show you the Malaria parasites, and I am certain that when you saw them, you would take a keen interest in the subject of this Lecture; but, in lecturing to a large audience, it is impossible to show you these parasites, and it must be a much more difficult matter to convey to you in a Lecture an idea of what they are like. I shall, however, endeavour, by the aid of Lantern slides, to convey to you some idea of their appearance; but as the picture of a horse conveys only a very limited idea of the qualities of the horse, so the illustrations which I shall show you in the Lantern will give you only a very limited idea of the qualities of the parasites, for they will not represent one of the most important characteristics of the parasites, *viz.*, motion.

Last year I taught some Burmans how to use the microscope and some other prisoners how to take temperatures. The Burmans have become wonderfully expert in the use of the microscope, and there are several who can find the parasite very quickly and distinguish the different parasites from each other, and who know as well, if not better than I do, the various stages in the life-history of a parasite. With their assistance we have had a very exceptional opportunity of making investigations into the Malaria parasites and fevers as we find them here in Nagpur.

DISCOVERY OF THE PARASITE.

Many of you have only heard of these parasites in quite recent years, and perhaps there are some among you who have never heard of them at all. I think, that before I go on to describe the parasites more particularly it will be of some interest if we look back and enquire how it was that they came to be discovered. From what we now know it must seem a greater puzzle to understand how it was that they escaped discovery than it is to explain how they came to be discovered.

The credit of having made the discovery lies with a Frenchman, Charles Alphons Laveran. He was born in 1845, graduated as a Doctor of Medicine in 1867. He was appointed a Professor in the Military School of Medicine in Paris in 1874. It was in 1880 while serving in Algeria that he made the discovery which has made his name famous. The parasites which he described were for many years known by the name of Laveran's bodies.

In some parts of Italy malarial fevers are very prevalent, and the Italians soon began to enquire if there was any truth in Laveran's statement. They were a little doubtful, at first, but soon they began to see that the Malarial fevers are caused by the small bodies described by Laveran, and they further were able to distinguish and describe the different kinds of parasites which are found in different kinds of malarial fevers.

Still, the rest of the world was in doubt, until Manson took the matter up, and now under the stimulus given by him, the study of Malaria has been taken up energetically by men of every civilised country in the world, and perhaps by no one with more energy than Major Ross, formerly in the I. M. S., now Professor in the Liverpool School of Tropical Medicine. It is a curious thing that one of the last countries to take the matter up is the country which perhaps suffers more than any other from the Malarial fevers, and that country—I need hardly tell you—is India. Even as late as two years ago, there were some men of high standing in the Medical Profession in India who did not believe that the bodies described by Laveran had anything to do with the Malarial fevers at all.

THE BLOOD.

Before describing the parasites it will be advisable to give a short account of the place where they live, *viz.*, the blood. I often ask people what the blood is, whether it is a fluid or otherwise, and the answer most frequently given is that it is a fluid. Well—that is not quite correct, for when you look at the blood under a microscope you see a number of small round discs in the fluid part of the blood which is called the plasma. In a drop of blood there are roughly about 300,000 of these small discs or corpuscles, and in a man of medium size there would be something like 3 thousand millions of corpuscles altogether.

It is in the blood corpuscles that the Malaria parasites live chiefly, and when one has got into a blood corpuscle it usually eats the whole corpuscle entirely away.

These corpuscles are $\frac{1}{3200}$th of an inch in size, and several of the parasites are as large or larger than an ordinary corpuscle when they are full grown. Many of the more common microbes are about $\frac{1}{25}$th thousand of an inch in size, so you see those that cause Malaria are really very large when compared with the majority of microbes.

The blood corpuscles of man are round discs and the blood corpuscles of most of the Mammalia or animals which suckle their young are round. In birds, reptiles, amphibia and fishes, the corpuscles are oval, and all these contain a central portion or nucleus which appears of different colour and texture when looked at under the microscope from the remaining part of the corpuscle. When speaking of the Malaria parasites in birds later on, I shall show how the parasites never eat up the nucleus.

There are several other kinds of corpuscle that are found in the blood; but as it is the red blood corpuscles that are attacked, it will not be necessary to describe these others.

Having given you a short account of the part of the body in which the parasites live, I shall now try and convey to you how we can find them. When we draw a drop of blood from the body, the corpuscles have a great tendency to adhere together in rolls or columns, like piles of coin, and when they are thus joined together it would not be possible to see the parasites inside them. We have therefore to take special precautions when taking a drop of blood for examination so that the blood corpuscles will be spread out and be slightly separated from each other. If there is the least trace of grease or dirt on the finger of the person whose blood is being drawn, or on the slide or cover glass, the blood will not spread out on the glass, but will form a small clot, in which nothing can be seen. If, however, we wash the individual's hand well first with soap and water, and afterwards with alcohol, so as to remove every trace of grease, then, make a very small puncture in the tip of the finger with a needle, we are able to get a specimen in which the blood so spreads out that the corpuscles are lying flat and separated from each other. In a good specimen there are very few corpuscles in the centre of the slide. Towards the circumference the corpuscles lie side by side and still further out they are found in "*rouleaux*."

Some of the parasites are larger than others; some occupy the whole blood corpuscle and others only take up a small part of it. There are altogether four different kinds of parasites—a fifth has been described by some writers, but only four have been found here. They are Quartan, Benign Tertian, Malignant Tertian, and Quotidian.

The parasites may be divided into two groups—the large ones and the small ones. If you think of two large animals—the cow and a horse, and two small animals—a sheep and a goat, it will help you to fix in your minds the idea that there are two large and two small parasites.

The large ones are two in number—the Quartan which takes 72 hours to develop and the Benign Tertian which takes 48 hours to develop. The small ones are also two in number, and here also we have a Tertian called the Malignant Tertian and which takes 48 hours to develop, and a Quotidian which takes only 24 hours to develop.

Points common to all.

There are some points which all have in common. They all live inside the red blood corpuscles; all have a fairly definite period of growth—Quartans 72, Tertians 48, and Quotidians 24 hours. When young they look like a clear space inside the red blood corpuscles.

PIGMENT.

All the parasites form what is called pigment or colouring matter, and this is always black. The pigment in some is in large granules; in others it is in rods. In some it moves slowly, in others it moves rapidly, and these differences in shape and mobility help us to distinguish one kind of parasite from another.

AMŒBOID MOVEMENTS.

They all move, and their movement is what is called amœboid, *i. e.*, it is more a change of shape than a change of position. Here is an illustration showing the different shapes which a young parasite may assume in 5 minutes. It may at first be round. Then a small arm may project out from one side, another projection may protrude from another side, one of these may be drawn in, and another move gradually out from another part of the parasite. In some, amœboid movements are very active and can be seen as you can watch the parasite: in others, the movements are slower, and the fact that the movements are going on will be more readily recognized if a drawing is made of the appearance of the parasite, and another drawing is made a minute or two later.

ROSETTES.

When they are full grown they all reproduce others of the same kind by what is called fission, that is, by division of the adult body into a number of parts. The pigment in the full grown parasite is seen moving actively near its circumference; it then gradually begins to come in towards the centre, and at the same time it can be seen that the parasite is beginning to divide into segments. We have often kept parasites under a microscope for several hours, and have watched this process of fission. When the fission has begun the parasite gets into what is called the Rosette stage. In Quartan fever the Rosette is very beautiful, and wonderfully regular in its appearance, with the pigment collected in the centre and 8 or 10 spores arranged around in a very regular manner. It must be a great source of comfort to you when you are shivering at the commencement of an attack of fever to know that you have a few thousands of such nice artistic looking objects in your blood.

The number of parts in a Rosette differs in the different parasites. Some divide into 6 parts, some into 8 or 10, and some into 20 or 30.

When the Rosette has fully formed it breaks up into several parts, and each small part or spore, as it is called, goes off on its own account, attaches itself to a blood corpuscle, and starts on a career of its own.

TWO METHODS OF REPRODUCTION.

There are many small members of the animal kingdom far down in the scale which reproduce their own species in this way, that is, by fission or division and

without any distinction into male and female. As we come higher up the animal kingdom we find what is called the sexual method of reproduction, and the males are distinct from the females.

Now, the curious thing about these Malaria parasites is this—that they reproduce themselves both by the asexual and by the sexual method. I have already described the asexual method by fission or division up into a number of parts, and later on, when speaking of one kind of fever—the Malignant Tertian—I shall tell you of the other method of reproduction, or sexual method, and tell you something of the males and females.

Staining.

There is another point of agreement in all the parasites: they all stain readily with a stain or dye, called methylene blue.

We have seen, then, that all the parasites have a number of points in common; they all look like a clear space in the red blood corpuscles; they all form pigment; they are all amœboid; they all divide by fission into a number of parts; the young parasites all go off on their own account and take up their abode in a fresh corpuscle; they all have a definite period of growth; and they all have two methods of reproducing their own species,—the asexual and the sexual.

Distinguishing Characteristics of Parasites.

It is very easy to distinguish the parasites from each other, and some of our men who can neither read nor write can tell a quartan from a tertian with as great certainty as they could distinguish a horse from a cow.

I shall first tell you how the large ones differ from the small ones, and then tell you how the two in the large group differ from each other, and how the two in the small group differ from each other.

The large parasites fill the red blood cells, and the small parasites occupy only about $\frac{1}{4}$ of the whole of a red blood corpuscle. But the most remarkable difference is that the small ones form bodies of a crescentic shape called "crescents" and the large ones do not form crescents.

The Quartan can be easily told from a Benign Tertian, although both fill the red blood corpuscle; for while in the Quartan we find the red blood corpuscle slightly contracted in size, in the Benign Tertian we find it always a little enlarged. The pigment in the Quartan is in coarse granules and moves slowly, while in the Benign Tertian the pigment is in long rods and moves about rapidly. The number of parts in the Rosette in Quartan is about 8 while it is about 20 or 30 in the Benign Tertian.

QUARTAN PARASITES.

The next three slides show Quartan parasites—one day old, two days old, and three days old.

QUARTAN FEVER.

I shall now show you a few charts to illustrate the nature of the fever produced by the large parasites, and we shall take first of all a few charts of Quartan. The Quartan is a very persistent fever and comes on regularly every third day, or what many of you would call every fourth day (Charts of Clear Quartan.)

When giving medicines to check a particular disease, we often have difficulty in saying whether any improvement which may follow the medicine is the result of the medicine or is a result of a natural tendency to cure, but Quartan fever is an exceptional disease in this respect. If we give no medicine it keeps on recurring for a very long time. We have made many experiments in Quartan fever cases in the past year. I have asked Native gentlemen who have visited the Jail Laboratory whether they think that quinine has a good effect in stopping Quartan fever. The answer they have almost invariably given is that Quartan fever is not stopped by quinine. I have asked them to pick out any case, and told them that if the paroxysms are not stopped for a time by one dose of quinine (gr. xx) I should make a present to them of Rs. 100. They have picked out a case, and the one dose of quinine has been given. The result has been in every case that the fever was stopped for a time at least. One dose is not sufficient to kill all the parasites, but after the one dose only a very few will be found, and the fever will stop for a week or two or more.

Now many people believe in arsenic and will refuse to take quinine. I shall show you a few charts to illustrate the effect of arsenic, and you will see that in every case to which we gave arsenic the fever did not stop, and in several cases it was higher than it had been before. It may be said that we did not give enough arsenic, and that if we gave larger doses the effect might have been good. Well, we gradually increased the dose until some patients had taken as much as half a drachm of Liquor arsenicalis daily (an almost poisonous dose) and what was the result ? You will see from the charts that the temperature was more often higher after the large dose of arsenic than lower.

Here, then, is a very important fact that we proved by the experiments that were made. Many people believed that quinine was of no use in Quartan fever, and many believed that arsenic was useful in this fever. Our experiments have proved beyond the shadow of a doubt that arsenic is utterly useless and that quinine has a really marvellous influence on the parasites and stops the fever. There was not one case in which it could be said that the fever was stopped by arsenic, and there was not one case to which quinine was given in which it was not perfectly clear that the quinine killed the parasites and stopped the fever.

There is not perhaps any other disease in which the effect of a medicine can be so clearly and satisfactorily tested.

Benign Tertian Parasites.

We now come to the fever caused by the other large parasite. It is called the mild Tertian or Benign Tertian, to distinguish it from the severe Tertian or Malignant Tertian.

The young Benign Tertian has a very characteristic appearance. You often see, what looks like, 4 or 5 small parasites in one corpuscle, but it is really only one parasite with long arms and the pigment collected into the ends of these arms.

The full grown parasite has also a very characteristic appearance. It is the largest of all—somewhat larger that a red blood corpuscle—and the pigment in rods is moving rapidly.

Benign Tertian Charts.

I shall show you a few charts to illustrate the nature of this fever, and there are a few special characters about this fever to which I would wish to draw your attention.

In the first place there is a severe shivering fit. The rigor or shivering stage is much more marked in this fever than it is in any of the others.

Another peculiarity of it is that you often get very high temperatures in this fever, and I shall show you some charts in which you will see that the temperatures run up to very close on 107°. It will seem strange that the fever in which we get such high temperatures should be called a Benign Tertian fever, but the temperature does not stay high for a long time. The patient soon has very free and profuse perspiration and the temperature rapidly falls, leaving the patient comparatively well.

There is another peculiarity about this fever, *viz.*, that the day of fever is liable to change. By this I mean that if the fever is coming on the even days, say the 2nd, 4th, 6th, 8th, it may alter, and the fever may come on the 9th, 11th, 13th. The parasites do not get into the rosette stage exactly after 48 hours; some of them develop slowly. If we compare the Quartan with the Benign Tertian in this respect we will see that a Quartan never changes its day. If it comes on the 3rd it will come on the 6th, 9th, 12th, 15th.

This may not seem an important point; but I would ask you to remember it as I shall refer to it again when speaking of Malarial fever in sparrows. I shall show you some charts of Malarial fevers in sparrows, and you will see that in a sparrow quartan the day never changes while in a sparrow tertian the day often changes.

The fever is rather persistent but yields readily to quinine.

PART II.

SMALL PARASITES.

I have told you of the large parasites and the fever caused by them. I shall now tell you of the small parasites, or of one of them at least—the Malignant Tertian—for the Quotidian is very rare.

In the Malignant Tertian we find the parasites in four shapes or stages :—

1st, the young forms, and these, as usually seen, look like small rings, filling about one-fourth part of the corpuscle;
2nd, the rosettes; but these are very rarely seen in the peripheral blood;
3rd, the crescents; and
4th, the spheres.

The ring forms grow and form spores very much in the same way as the larger parasites already described. After 8 or 10 days we begin to find crescents. The ring form puts its back up against the side of a corpuscle and grows at the expense of the red blood corpuscle, gradually taking away all the colouring matter from it, and leaving only a clear part which we have called the belly part. The belly part is absorbed, and then we have the fully-formed crescent.

SPHERES.

If blood is drawn from a case with crescents, flagella may be seen. The crescent changes first into an oval shape and then becomes round. The pigment granules begin to dance about very rapidly, and as we watch, we see the red blood corpuscles in the neighbourhood much disturbed and their edges turned up. After a little while we can see that it is a number of small clear, almost transparent, filaments that have been thrown out from the spheres that are causing this disturbance. No illustration will give you an idea of this movement; but if you could imagine 4 or 5 snakes tied together by the tails and all struggling vigorously to be free, this will convey some sort of idea of what happens.

TIME FOR EXFLAGELLATION.

Manson had noticed that exflagellation, as a rule, does not take place for some minutes after the blood has been drawn, and probably in old cases which are seen in England, that observation is correct; Drs. Stephens and Christophers, Members of the Royal Society's Malaria Commission, noticed in Africa that exflagellation was sometimes seen in freshly-drawn blood. In the investigations which were made here, we found that there is a fairly definite period when the crescents readily change into the spheres.

Discovery of Flagellar Fever.

Many people came down to see the Malaria parasites, and we used to show them the flagella, if possible. For some time we did not know in what cases they were most likely to be found; but one day Ko Tha Aung said to me that in crescent cases you always find spheres if the patient gets fever. We then began to enquire whether there was any truth in this statement, and we found that in a great many of the Malignant Tertian cases there is a fairly definite period, when spheres can always be seen. It is about the 12th to the 15th day, and if there are many spheres to be found, there will nearly always be fever; to this fever we gave the name of Flagellar fever, and it is in the prevention of it that we think our chief attention should be given in treatment.

Parasites in 3 forms, and 3 parts in Charts.

There are three forms in which we usually find the Malignant Tertian parasites, and there are three parts in the Malignant Tertian chart corresponding with the three different stages of the parasites. We find the ring forms in the primary fever, then an interval of little or no fever when crescents are forming, and third the secondary or flagellar fever when the crescents are changing into the spheres.

Flagellar Fever.

The Secondary fever or Flagellar fever had not, as far as I am aware, been described by any one before we noticed it here. Manson had spoken of the liability to relapse after 10 days or so, but the relation of this fever to the readiness of exflagellation had never been described.

Importance of recognising the Flagellar Fever.

The recognition of the Flagellar fever is of great importance from a practical point of view. Before we had discovered it we frequently found that men who had been admitted to hospital for Malignant Tertian fever and had been discharged from hospital when their fever had apparently stopped, would return again after a few days. Now we know that in such cases we will find spheres and probably a secondary fever, and we know that it is not advisable to discharge men from hospital until efter the flagellar period has passed, unless we are certain that the formation of crescents has been prevented.

Old rule.

It was an old rule to keep a man for three days in hospital after his fever had stopped, but now we know that in the case of some fevers this is a great waste of valuable time.

Phagocytes.

There are several different kinds of white blood corpuscles in the blood, but there is only one of these which I shall tell you of now. It is called a phagocyte

or eating cell, because it eats up foreign matters that happen to get into the blood. This can be seen at no time so well as when flagella are being given out. They move along the microscopic field by a sort of flowing motion, and when a flagella body begins to throw out flagella, if there is a phagocyte any where near, it soon envelopes the flagella body and eats it up. It is impossible to give by an illustration any idea as to what a phagocyte looks like.

MALARIA IN SPARROWS.

I shall next tell you of the investigations we made regarding the Malaria of Sparrows.

But you will say—who cares whether sparrows get fever or not ?

VALUE OF INVESTIGATING MALARIA IN SPARROWS.

But the investigation of sparrow malaria may be important from one point of view. To illustrate what I mean, I shall refer to what happened at the Congress on Tuberculosis that met in London recently. It had for many years been taken for granted that the tubercle of man was caused by the same germ as that which caused tubercle in animals. Koch astonished the world by announcing that they are not the same. It had been thought in England that if tubercle could be prevented in cattle it would be largely reduced in men, but if Koch's view is correct, then all the elaborate precautions that have been taken in England are wasted labour and money as far as the prevention of tubercle in man is concerned. Koch's opinion is perhaps not generally accepted, but I have brought this forward to illustrate how important it is to enquire what is the relationship between the diseases of man and animals or birds.

WHY CHOOSE SPARROWS ?

Would you like to know why we chose sparrows ? Well the choice lay with the sparrows and not with us. We gave an invitation to other birds to come and take part in the investigations, but the wily crows refused to accept the invitation and other birds also seemed reluctant to come into the inviting traps that were laid for them, but the sparrows came in large numbers.

NUMBER OF SPARROWS EXAMINED.

We examined the blood of about 300 sparrows and had their temperatures taken twice daily. The temperatures were entered in charts and the record showing the number and kind of parasites found in the blood daily was entered at the foot of the charts.

DISCOVERY OF TERTIAN AND QUARTAN IN SPARROWS.

We made rather a surprising discovery, for we found that the sparrows get Tertian and Quartan fever. We found that there are many points of resemblance

between the Quartan parasites of man and the Quartan parasites of sparrows, and that there are many points of resemblance between the Tertian of sparrows and the Benign Tertian of man. In May and June the malaria of man comes down to a minimum and the proportion of sparrows infected with parasites was reduced at that time.

We have seen, then, that at a time of the year when we have been finding Quartan and Benign Tertian parasites in men we have found Quartan and Tertian parasites in sparrows; that the parasites of sparrows in many respects resemble those of man; that the special peculiarity of the Quartan in man, the "high," "low," "lower" temperature is also well seen in sparrows; that the special peculiarity of the Benign Tertian in man, the tendency to change of day is also well seen in sparrows; that quinine has a marked effect on the Tertian of sparrows; that there are usually about 8 or 10 spores in a human Quartan, and there are about 8 in a sparrow Quartan, and that there are about 20 in a human Tertian, and about the same number in a sparrow Tertian. We have seen here in the Central Provinces very often that the worst cases of fever are found in men who have been working or "shikarring" in the jungles far away from human habitation, and if malarial fever is conveyed from man to man, and from man to man only, how can the excessive severity in such cases be explained?

There are some points of difference between the parasites of man and those of sparrows, but whether these differences are due to environment or to the parasites being totally different, I am not prepared to say.

Koch's views.

Professor Koch has said that the malaria parasites of man are confined to man, and that as the malaria parasites are conveyed from man to man and from man to man only, then if we kill the parasites in man, we should be able to wipe them out altogether, but before acting on this assumption we should I think make it certain that the parasites of man are not the same as those which are found in other animals or birds. I do not say that those which we found in sparrows are the same, but what I say is this, that they bear such a strong resemblance to those of man that we ought to make further enquiries before deciding to rely solely on the method of prevention recommended by Koch.

Mosquito Curtains.

In the Lecture which I gave here last year I told you of the experiments that had been made in Italy by getting a number of people to remain inside mosquito curtains between sundown and sunrise. Many similar experiments have been made since, and I take the following results from a paper by Manson that appeared in *The Practitioner*. You will see that in each place there were some people protected by mosquito curtains and there were others (as a check experiment) who were not in

this way protected. The proportion of attacks among those who were protected by the mosquito curtains was very small compared with the number of attacks in the unprotected :—

Protected.		*Unprotected.*	
Number.	Got fever.	Number.	Got fever.
52	... 2		Almost every one.
52	... 0	51	Only 7 escaped.
36	... 2	52	Only 7 escaped.
30	... 2	37	Only 3 escaped.
104	... 3	25	All got fever.

But you will say these experiments were made far away—in another country —by people that we don't know, and how are we to say if they are true or can be relied on ? Well—I'll tell you of an experiment that we made here in the Nagpur Jail. Early in September we put 36 men in mosquito proof cages. The fever season has now passed, and what has been the result ? How many of these men have been attacked by malarial fever ? None.

There are 8 barracks in the same side of the Jail where the mosquito proof cages are, and in these the numbers locked up and the numbers attacked by malarial fevers were :—

Protected.			*Unprotected.*		
Bk. No.	No. of prisoners.	Got fever.	Bk. No.	No. of prisoners.	Got fever.
5	36	None.	1	74	8
			2	72	7
			3	69	4
			4	70	4
			6	54	2
			8	71	4
				410	29

VALUE OF THE MOSQUITO CURTAIN.

This seems to be very conclusive evidence of the value of a mosquito curtain; and now the question remains how does the mosquito curtain act ? Is it by excluding the mosquitoes which carry the fever germs, or is it by excluding germs that may be carried about by the air ?

CONCLUSION.

Whatever view we may take as to what has been done in the past—whether more might have been done than has been done—there is no doubt that a great

movement has now been started. For we have the Royal Society sending a Commission consisting of most able and enthusiastic men—men whose ability and powers of investigation have been the subject of our highest admiration. We see the Government of India sending from places as widely distant as Lahore and Madras—as Calcutta and Bombay—men who have already distinguished themselves in scientific investigation, to draw up a plan of Campaign against the Malaria parasite and one of its hosts—the Anopheles.

It may be many years before we are able to persuade the general Native population to take advantage of the recent discoveries that have been made, but still I am a firm believer in the Native as a practical man, and when once he has been convinced that the Malarial fevers are caused by parasites which can be easily seen and recognised, and when he has become convinced that these parasites are carried by Mosquitoes, he will take steps to clear away those mosquitoes that carry the malaria.

But in the meantime there is a large European population, including that great body of men—so much despised by some people a couple of years ago, but now so highly respected—the 70,000 British soldiers in India, and what is being done to prevent their getting Malaria, or what is being done to give them the benefit of the knowledge derived from the discovery of the Malaria parasite over 20 years ago? In how many Military Stations do we find microscopes? It may be said that this is due to want of keenness on the part of the Officers of the R. A. M. C., but this I can very emphatically deny, for I have met many keen men, and men who are most anxious to use microscopes in the diagnosis of their cases, but knowing that they may be here to-day, and 1,000 miles off next week, they have not been able to carry about with them the materials required.

Why should there not be a small Laboratory established in every Military Station with the necessary microscopes and apparatus for examining blood? We have been able to teach some men, who can neither read nor write, to detect and distinguish these parasites in a few weeks, and surely some Hospital orderlies could easily be trained also.

The advantage of having such an institution or the disadvantage of not having it was forcibly brought to my mind not long ago. A Colonel Commanding a British Regiment in a down-country station had been suffering from fever. It was thought that the fever was due to some inflammation of his liver, and after a few small doses, the administration of quinine was stopped. He was sent for a change of air to Nagpur, and one day, while visiting the Jail Laboratory to see the Malaria parasites, he had his blood examined. He had had fever—an interval of freedom from fever—and fever again—the typical history of a Malignant Tertian fever—and when we looked at his blood we found, as we expected to find, spheres actively throwing out flagella.

This fever might easily have been checked earlier, and I thought that if he —the Colonel of a British Regiment—was allowed to suffer from a fever which might easily have been checked, what can be said regarding the now much-respected Tommy Atkins?

He was so struck with what he had seen that he determined to buy a microscope and present it to his Regimental hospital, and not only that, but said he would try and learn how to find the parasites himself.

That is the spirit that is required; that is the spirit that we want to stir up. Medical men may investigate and find out parasites, but as Colonel Bourke, R. A. M. C., from Mhow, said to me the other day "we want to get the people "generally, and especially the higher Civil and Military authorities, to take the "matter up, and then—we may expect good results."

In a picture which appeared in a recent issue of *Punch*, John Bull (typyfying the people of England) was represented taking Lord Salisbury by the shoulder and saying to him "Wake up, and put an end to the Boer War without delay, and we "will back you up." Now, I believe if the people of Tropical climates would say to their Medical men—we want you to stir yourselves up and enquire where these Malaria parasites come from how they are carried, and how they can be got rid of, *and we will back you up*, then—a time would soon come when these parasites would be abolished, and we should be free from one of the greatest banes of existence to those whose lot is cast in Tropical climates.

I have introduced you to the parasites of Malaria; and I will conclude by expressing the wish that your knowledge of them will increase, but that any additional knowledge which you may acquire will be derived from external observation and not from personal experience.

SPEECH BY THE HON'BLE Mr. A. H. L. FRASER, C. S. I., CHIEF COMMISSIONER, CENTRAL PROVINCES, AT THE OPENING MEETING OF THE MALARIA CONFERENCE.

Ladies and Gentlemen,—I daresay that none of you are aware that we have been listening to lectures for more than an hour and a half. The lectures to which we have been listening have been so interesting that I could not believe my eyes when I consulted my watch before rising to speak. I shall, therefore, only detain you long enough to say two words.

My first word is that I desire, in your name and in my own, to extend the most cordial welcome to the Royal Society's Commissioners and to the selected Medical officers from other Provinces who have come to attend this Conference on Malaria. I have been much gratified to hear from the Royal Society's Commissioners that they find exceptional facilities for investigation here. The credit of this is due to Major Buchanan who, of his own initiative and by his own energy, has established an excellent laboratory at the Central Jail. It may be said that this is due to the fact that wonderful assistants have come to him even from across the seas, and to the favourable circumstances in which he finds himself for investigation. But he has seen, if he has not even made, his opportunities; and I think that a man who discovered the Burman Ko Tha Aung is entitled to almost as much credit as though he had discovered a parasite. We are very proud to think that the Government of India have sent Medical officers from all provinces to Nagpur to take advantage of the opportunities which exist here for research. I daresay that not a few of the officers whom we are welcoming had no sort of notion where Nagpur was, when they received their orders, and had to make anxious inquiries as to the best means of getting there. It is a pleasure to think that, thanks to the professional spirit of our lecturers of this evening and their colleagues, we are now well known in the Medical world. It is, therefore, with pride as well as pleasure that I extend, on behalf of the province, a hearty welcome to our visitors.

The second word that I desire to say is that I thank very heartily, in your name and my own, Colonel Scott Reid and Major Buchanan for the lectures to which we have just listened. As I think of my burly friend Colonel Scott Reid studying the lives and loves of these malaria parasites, I am reminded of a picture that used to delight me in my youth of Gulliver studying the lives and loves of the Lilliputians. And the interest with which I have listened to Colonel Scott Reid this evening is that with which I used to listen to Swift. And, though I have seen most of Major Buchanan's pictures before, I have seen them with no less interest, but perhaps (owing to some increase of knowledge) with even greater interest to-day. I desire, therefore, to thank the lecturers for the treat they have given us.

LADIES AND GENTLEMEN,—will you indicate by very hearty applause how fully you adopt the two proposals I make, namely, that we extend a cordial welcome to our visitors, and that we thank the lecturers of this evening. [Loud and continued applause.]

SECTION II.

MALARIA.

MALARIAL FEVER WITHOUT PARASITES IN THE PERIPHERAL BLOOD.

ABSTRACT OF PAPER BY DRS. STEPHENS AND CHRISTOPHERS.

In the examination of Europeans in West Africa suspected of having malarial attacks, and who presented a rise of temperature with more or less constant vomiting, headache, pains in the back, &c., blood examinations were not uncommonly negative, or the number of parasites was so scanty as to cause doubt if they could be causally connected with the attack.

The cases under consideration are those where quinine has not been taken previous to the blood examinations. It is difficult to prove that these are cases of malaria though clinically they appear to be so.

Two cases of experimental inoculation with sporozoites have lately been published* where a high temperature with other symptoms of malaria continued for three days before a single parasite was found. In the second case no parasites were found until the sixth day of the fever.

In both these cases,—had quinine been given early in the disease there can be no doubt that no parasites would have been found at any time.

Similar facts have been observed by Celli in Italy, and lately by Brault in Algeria. Both these observers record cases of undoubted malaria with an absence of parasites in the peripheral blood.

Quite another class of cases—where most frequently no parasites are to be found—are cases of so-called Malaria cachexia and enlarged spleen, so common in India.

Most commonly in these cases a blood examination is negative, and a post mortem examination of smears from the organs in the few cases we examined showed no parasites. The authors pointed out that in the absence of parasites in the peripheral blood, whatever be the cause, there still remain two valuable means of diagnosis. † [3]

(1) The presence of pigmented leucocytes.
(2) The increase in the percentage of the large mononuclear leucocytes.

These means of diagnosis are especially useful in cases where quinine has been taken before the blood is examined.

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* NOTE.—[1] Experimental Proof of Mosquito Malaria Theory. Manson. *British Medical Journal* September 29th, 1900, p. 950.

[2] Experimental Proof of Mosquito Malaria Theory. Rees. *British Medical Journal*, Oct. 6th, 1900, p. 1055.

† NOTE.—[3] Reports to the Malaria Committee of the Royal Society. Series I, V, Harrison and Son, St. Martin's Lane, London.

CAPTAIN LEONARD ROGERS wished to refer to two points in the paper, namely, the absence of parasites in the early stages of some cases of malarial fever, and the nature of the fever with few or no parasites in the later stages of chronic malaria cachexia. He was able to corroborate the evidence given in the paper as regards the first point, for in a microscopical investigation of 100 cases of intermittent fevers, the results of which were published in the *Indian Medical Gazette* of 1896, in all of which a single blood film taken before quinine had been given was examined, in only 33 was the malaria parasite found. A minute analysis of the notes and charts of the cases showed that they were all malarial, but the parasites were absent, or at least very scanty in the earliest stage of the majority of the cases.

MALARIA CACHEXIA.

With regard to the cases with greatly enlarged spleens, it is undoubtedly the case that malaria parasites may be absent for long periods when the so-called secondary fever is present, and in this stage quinine even in full doses administered hypodermically may have no effect whatever on the course of the fever. It is only by following up such cases from the earliest acute stage throughout all its phases to the post-mortem room that positive proof of the malarious nature of the entire affection can be obtained. This he had been able to do, more especially in Assam, where cases had been followed up for months, and malaria parasites occasionally found in every stage up to the day before death, (as in the case a chart of which is given in his report on *Kala-azar*), especially during the marked exacerbations of the fever which interrupt now and then the low secondary fever. These cases, then, were certainly malarial, and the acute stage shaded insensibly into the chronic ones.

MELANOTIC PIGMENTATION.

Further, in such cases melanotic pigmentation was found in the spleen and often also in the liver, being present throughout the spleen pulp in those cases in which distinctly malarial exacerbations had occurred shortly before death, and in the trabeculae more especially when no such attacks had taken place during the last few weeks of the disease.

ATROPHY OF INTESTINES.

He had been much struck by the frequency in these chronic cases of a pigmented atrophy of the mucous membrane of the small intestine, as well as of an irregular and chronic form of diarrhœa, (quite distinct from the terminal dysentery often seen in Calcutta and in jails), accompanied with great wasting and such complete loss of digestive power that unaltered starch grains could often be found in the fæces when looking for the ova of worms. Sections of the small intestine in these cases showed every stage of atrophy of the mucous membrane accompanied

by melanotic pigmentation down to an almost complete disappearance of both the villi and tubular glands, little but fibrous tissue and pigment remaining. He had prepared microphotographs of such sections in 1899, but lost all the material in a fire. Recently he had confirmed these observations in cases of chronic malaria in Calcutta, and hoped to publish details shortly. There was no doubt that this form of pigmented atrophy of the intestinal mucous membrane was a very serious and fatal complication of malaria cachexia, and cases in which the diarrhœa which accompanied it, was present, very frequently ended fatally.

Secondary disease of the Liver.

In the Assam series the liver was enlarged in 93 per cent of the cases, often markedly so, but sometimes in the most chronic cases, the liver was contracted.

The low Secondary Fever.

The nature of the low secondary fever without parasites remains to be elucidated, but the following theory, based on anatomical evidence, not yet published, was put forward as a possible explanation. He had for some time thought that these lesions in the intestines might cause the secondary fever without parasites by allowing of the absorption of an excessive amount of the poisonous products formed during digestion through the thinned mucous membrane of the small intestine.

Treatment.

The only treatment which sometimes seemed to have a marvellous effect in this condition is bone-marrow, which might be given in tabloid form. He had been led to try this by observing that in cases of chronic malaria the yellow marrow in the shafts of the long bones was always transformed into red marrow, often of a dark red colour.

Captain Birdwood said :—

Captain Rogers states that he has found atrophy of the intestinal mucous membranes in these Cachectic cases. These cases appeared to him to be very largely ones of general constitutional break-down in which the nervous tissue also largely partakes, so that the *thermogenic* centre is unable to control steadily the body temperature, and slight irregular fever results. That no parasites appear in the blood, seems possible from the fact that it is always a post malarial condition, and no recent infection has occurred.

MAJOR BUCHANAN said that there is no doubt that the presence of pigmented leucocytes is often of considerable value, and in cases with only a slight infection the first indication of infection often is the presence of pigmented leucocytes. Provided however that long and repeated searches have been made, and that no quinine had been taken, it has usually, here, been possible to find parasites. In Quartan cases the parasites were always found without a single exception. In Benign Tertian cases they have also been found. In Malignant Tertian cases it is sometimes difficult to find the parasites on the first or second day. In a separate paper, which is at present under preparation, reference will be made to the hourly variation in the number of parasites, and it will be seen how in Malignant Tertian cases a large number of parasites may be found in the morning and very few in the evening, or *vice versâ*.

He had seen two cases which at first appeared to be malarial, but in which no parasites could be found. In both of these there was an evening rise of temperature for a few weeks, and the morning temperatures were nearly normal. One of these cases turned out to be typhoid—though a very atypical case—and the blood gave a good typhoid reaction, when tested by Captain Lamb. The other died, and the post-mortem showed what must, he thought be very rare, an abscess of the spleen.

He believed that in this part of India it would be possible to find parasites at some time in the peripheral blood of all cases of Malarial fever.

MALARIA CACHEXIA.

In some cases of Malaria Cachexia he had found Benign Tertian parasites, and in others he had found crescents, but in some no parasites could be found, even after prolonged examination.

COLONEL SCOTT REID remarked that his attention had been specially drawn to the typhoid case referred to by Major Buchanan and it had been pointed out to him that it was the only case which looked like a malarial fever in which parasites could not be found in the blood.

MAJOR GRANT said that he had listened to the paper just read with great satisfaction. He had often tried to impress upon students and others, frequently with but scant success, he was afraid, that, in patients admitted in a condition of advanced Malaria cachexia, it was the rule, rather than the exception, for the parasites to be absent. If one remembered that a large number of admissions into hospital, *e. g.* in Madras, was of this type, that quinine *had* to be given after 24 hours at the longest to ordinary cases, so as to make room for others, and that the hours of observation

were, in general, strictly limited to a period of the day unsuitable on the whole, there would not be so much scepticism, expressed or implied, either as regards the *rôle* of the parasite or the ability of the observer to detect its presence.

With regard to the condition known as malaria cachexia he could only speak from Indian experience, but he had had plenty of that. He knew of no clinical picture more strongly-drawn nor more easily recognised than such a state. Judging from some modern writings, one would think that fever and enlarged spleen covered the ground, a most mistaken idea. It would, in fact, be nothing less than disastrous if anything was done to obscure the clear recognition of this symptom-group, for which there exists no other adequate name, and which, he would state, after very large clinical experience, could not possibly be mistaken for anything else by any one with even a moderate amount of medical experience in India. Captain Rogers had referred to the condition of the intestine in such cases which ended fatally, and the speaker was in entire agreement with him. The intestine, in fact, in such cases, presented very much the condition of extreme atrophy of its tissues met with in famine, and famine *plus* malaria subjects. If he remembered correctly, Chevers gave a graphic description of the stage in which assimilation of food becomes practically impossible, under the heading of *morbus Bengalensis* for want of a better name.

MALIGNANT TERTIAN FEVER.

BY

MAJOR A. BUCHANAN, I. M. S., M. A., M. D.

In the small book on Malarial Fevers and Malaria Parasites in India, which has been recently published, I gave an account of some observations which had been made in Nagpur on the parasites seen in the Malignant Tertian fever and I showed that there is a fairly definite period when spherical gametes are found, that when exflagellation is at its maximum there may be fever, which I called the Flagellar fever, and that after this fever, in some cases, a third fever appears, during which the ring forms will be found again.

During the past fever season a number of cases were picked out and treated with rest in bed and without the administration of quinine, until after the natural course of the fever had been observed for a certain time. The blood was examined

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NOTE.—The terms used by different writers are not the same. Some call the spherical gametes "gametocytes"; the flagella are called by some the "microgametes"; and the female spherical gamete is called by some the "macrogamete."

daily, and the number and kind of parasite found daily were entered in the charts. The temperatures were taken every two hours, from 6 o'clock in the morning till 10 o'clock at night, and the highest temperatures were afterwards entered in the charts. As, however, the printing of the charts would take up much space, the following method will be followed :--the number of degrees above normal (omitting decimals and taking the nearest whole number) will be entered, and only the highest daily temperatures will be given.

A few words may be said in regard to the

TERMS USED.

Rings :—The Ring form parasites are for the sake of brevity called Rings.

Gametes :—The sexual forms of the parasites are called gametes.

Crescents :—The gametes are at first crescentic in shape, and the word crescent is more convenient than crescentic gamete.

Spherical gametes or Spheres :—The male crescents change into spheres before giving out flagella, and the females also change into spheres. Formerly the term "flagella bodies" was applied to these spheres, but as the females do not give out flagella the term is objectionable when applied to both sexes.

Flagellar fever or Secondary fever :—This name has been given to the fever which occurs in the flagellar period (see below).

Counts :—The number of parasites counted in a particular slide is called the count.

METHOD OF MAKING COUNTS.

The counts were made in moist films and as soon as possible after the blood had been drawn. Crescents may change into spheres during the time the count is being made, but if on one day we find crescents and no spheres, and on another day we find many spheres and only a few crescents, the conditions of examination being the same, we are able to determine whether there is a particular time when crescents change more readily to spheres.

The counts given in this paper were made at a time when there were many cases to be examined and only a few minutes could be devoted to each, and as there is in Malignant Tertian cases a considerable variation in the number of parasites seen at different times of one day—(this subject will be dealt with in a separate paper)—it must be admitted that there is room for error to creep in. However taking the cases as we find them, and though the counts are far from being as complete as one would like, we may consider whether and how far they support the view already advanced that a case of Malignant Tertian may be divided into four periods.

FOUR PERIODS IN A MALIGNANT TERTIAN CASE.

1st period :—when Rings are found in the blood—the Primary fever period.

2nd period :—when crescents, mostly unripe, are found—the crescent interval.

3rd period :—when crescents are ripe and change readily into spheres. In this period which we called the flagellar period the secondary fever or flagellar fever occurs.

4th period :—when Rings again appear in the blood and fever for a third time may come on.

1st period or primary fever period.

A line joining the highest temperatures will often form an inverted V. The maximum temperature is reached on the 3rd, 4th or 5th day, and the maximum number of Ring forms is found about the same time. It is very rare to find a temperature as high as 105 in a Malignant Tertian case. A few days ago, we were surprised to find a temperature of 105·4 in a Malignant Tertian case, but on examining the blood, Benign Tertian parasites were found in addition to the Malignant Tertian. In Benign Tertian a temperature of 105 is common. The duration of the Primary fever of Malignant Tertian is about 8 days, but patients often do not come to hospital in the first few days. "I had slight fever the other day, but I thought it would pass off, and I didn't want to bother you"— is a remark we often hear at the beginning of a Malignant Tertian fever. It is important to remember that the number of parasites on the first day may be few, and that a long search may be required to find any, while on the 4th or 5th days there will be no trouble in finding them.

2nd period or crescent-forming interval.

In this period the crescents begin to appear and their numbers gradually increase. A few days after crescents appear, spherical gametes will be found, and the crescent-forming interval may be taken roughly to be the time between the appearance of crescents and the appearance of spherical gametes. In this period there is very little, if any, fever. The Ring forms are few in number and they gradually disappear altogether or almost entirely. There are a few cases in which they do not disappear, but possibly in such cases there may be two infections. In studying the cases which are given below, we have taken the Crescent interval as occurring from about the 9th to the 11th day, *i. e.* from the time when crescents usually appear till the time when spherical gametes usually appear.

3rd period—the spherical gamete period or Flagellar period.

If this period is divided into three sub-periods of about 3 days each, and if we take the totals of the numbers of each kind of parasite seen in these three sub-periods, we find that in many cases the crescents are more numerous than the spherical gametes in the first sub-period, while in the second sub-period the spherical

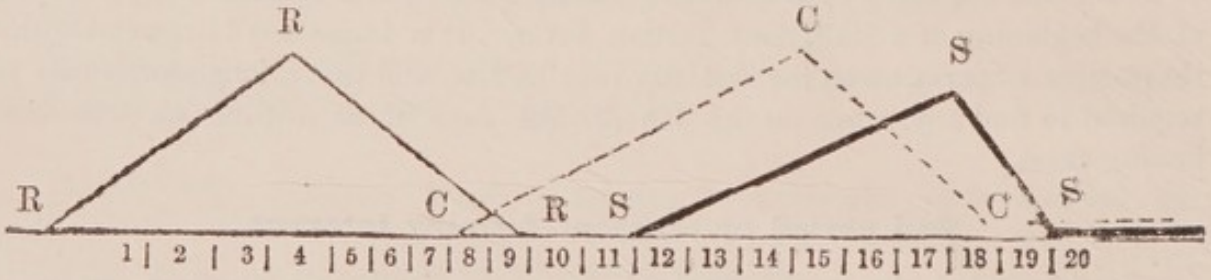
gametes outnumber the crescents. In several cases the number of crescents is almost double the number of spherical gametes in the first sub-period, while in the second sub-period the spherical gametes are often double the number of the crescents. In the third sub-period the spherical gametes often outnumber the crescents, but it frequently happens that several of the crescents do not become converted into spheres and remain as such in the blood.

In the flagellar period we usually find some fever though not always. It is sometimes of a tertian nature, being higher every alternate day; but it is not so distinctly tertian as the Primary fever. The fever is often highest in the second sub-period of the flagellar period, that is, when the spherical gametes are more numerous than the crescents, or when exflagellation is at its maximum.

4th period—Third fever period.

Then we come to the 4th period, and here we find fever coming on again—not in all, but in some cases. Here we find the ring forms again, and we also find crescents and spheres.

The number of parasites found in the course of a typical case might be represented diagrammatically as follows :—



the line RRR representing the Rings increasing and disappearing; the dotted line CCC representing the Crescents appearing, increasing, and almost disappearing; the thick line SSS representing the spheres appearing, increasing, diminishing, and almost disappearing.

The point where the thick line cuts the dotted line indicates the time when the spheres are more numerous than the crescents, and there is often fever at this time although ring forms are frequently not found.

In this paper I propose to deal chiefly with the observations that have been made about the time when the spherical gametes are seen in largest numbers. At this time the most striking feature when examining a specimen of blood is the flagella, and we gave the name Flagellar to the fever which occurs in this period, just as we sometimes referred to the Primary fever as a Ring fever. I do not propose in this paper to defend the use of these terms;—call it Gamete fever, a spherical fever, or a sexual form of fever—as you please.

We had noticed that if we wanted to show flagella to any visitor to the Laboratory, the time to get them in largest numbers, or most readily, was in a crescent case after fever came on, and we noticed that this was very often about the 16th day. We also noticed that after this time—the spherical gamete or the flagella period—the crescents and spheres diminish in numbers. Figures may be misleading, but what I propose to do now is to see how far the counts in the cases given below confirm the observations that had been already made.

1. Is there a period of maximum number of crescents (for brevity this will be called Max. C. and similarly the period of maximum number of spheres will be called Max. S.) ? See the figures in cases 1, 2, 3, 4, 5, 7, 8, 10, 11, 12 and 13, and see also cases 5 and 6, as far as they go. Granting that the omission of a case will weaken my argument, still I think it will be better to omit case IX because the early appearance of crescents shows that the case had not been under examination from the beginning. Max. C. must be admitted.

2. When does Max. C. occur ? From the table that will be given under question number 4 it will be seen that in 4 cases it is on the 12th day, in 2 on the 13th, in 2 on the 14th, and in 1 on the 15th and 16th days respectively. We may conclude, then, that it is from about the 12th to the 15th day,

3. Is there a period of maximum number of spheres (Max. S.) ? See the figures in cases 1, 2, 3, 4, 7, 8, 10, 11, 12, 13, and in 5 and 6, as far as they go, and you cannot help being convinced that there is a period of Max. S.

4. When is the period of Max. S.? The following table will show at a glance the days on which Max. C. and Max. S. were found; and in the third line of the table the number of days interval between Max C. and Max. S. is entered.

Case No.	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII
Max. C. ...	13	12	15	(11) 12	?	?	12	16	?	14	12	13	14
Max. S. ...	16 (18)	17	16 (17)	13*	?	?	15	17	?	18	19	14	16
Difference ...	+3	+5	+1	+1	?	?	+3	+1	?	+4	+7	+1	+2

*Quinine.

From this table you see that Max. S. is as follows:—

	13th	14th	15th	16th	17th	18th	19th
No. of cases ...	1	1	1	3	2	1	1

So there is a period of Max. S, and it occurs from about the 14th to the 19th day,

5. What is the relation as regards time between Max. C. and Max. S. ? In the table given under question 4 we see that Max. S. always follows Max. C. In 4 cases it is one day after, in 1 case 2 days after, in 2 cases 3 days after, in the other three cases it is 4, 5 and 7 days after, respectively.

6. Do we notice anything special as regards the fever at the time of Max. S. ? In the following table are entered the days of Max. S. in each case and the days of secondary fever or days of the highest secondary fever.

Case No.	Max. S.	Days of secondary fever or day of highest fever.	Remarks.
I	16-18	16-18-19	Temp. rising as S. increasing.
II	17	13-14-16	
III	16-17	18	
IV	13	12-13	
VII	15	13-14-15	
VIII	17	15-16-18	
X	18	16-19	
XI	19	19	
XII	14	14-18	? double infection
XIII	16	12-13-15-16	? double infection

You cannot help being convinced that there is a most striking relationship between the day of Max. S. and the Secondary fever.

7. Is there anything else to indicate a relationship between the Max. S. and the Secondary fever ? When the number of spheres is rapidly increasing we can often predict fever, or as fever is increasing we often find the number of spheres increasing at the same time, *e.g.*, see case 2—fever 2, 4, 5, 0, 4, and spheres 3, 4, 6, 8, 7. 9. In case 2 spheres 1, 2, 4, 4, from 14th to 17th and on 18th fever. See also cases 7, 10, and others. This tends to confirm the relationship referred to under the previous question.

8. Are Rings found in the Flagellar period or during the Secondary fever? In cases 1, 2, 3, 4 and 7 none were found. In cases 5 and 6 none were found as far as they go. In cases 3 and 10 some were found, but on some days on which fever occurred there were no Rings. In case 11 some were found, but it was a case with a large number of parasites in the primary fever, and in such cases it is usual to find a few Ring forms in the crescent interval and Flagellar period. Case 12 shows numerous Rings, but the unusual severity of the Secondary fever leads to the suspicion that it may have been a second infection. In recurrent cases Rings,

Crescents and Spheres are found at the same time, and case 13 may have been such a case. Altogether, the absence of Rings in the Secondary fever in so many cases is remarkable and leads to the belief that the Secondary fever is not due to the breaking up of Rosettes, unless we assume that the Ring forms conceal themselves during the Secondary fever.

(NOTE.—While this paper was in the Press, a case has been specially watched and long counts made. The secondary fever in this case is distinctly due to the breaking up of rosettes; it is a "*Ring*" fever rather than a "*Flagellar*" fever. It will be published later, but it shows that there is a lot to be done before we understand the Malignant Tertian thoroughly.)

9. After the Primary fever, crescents are found in increasing numbers in the blood; this will be admitted by all. But after the Secondary fever, are crescents found in increasing or in diminishing numbers? In cases 1, 2, 3, 4 they soon disappear. In cases 7, 8, 10, 11, 12, 13 their numbers considerably diminish. We have seen that after the Primary fever the crescents increase in numbers; we now see that after the secondary fever the crescents diminish or disappear. If we can judge from what we see in the blood, we must conclude that the process which is going on in the blood during the Primary fever is not the same as the process which is going on during the Secondary fever.

10. Are Crescents destroyed by phagocytes?

We have seen phagocytes attacking the spherical gametes hundreds and hundreds of times, but we have never seen a phagocyte attacking a crescent.

11. Are gametes found in phagocytes at the time the blood is drawn? Further attention must be given to this question before a definite answer can be given.

12. Are gametes destroyed inside the body? The reduction in the numbers shows that they must be, unless we assume that they are concealed in the internal organs.

13. Does the withdrawal of the blood from the body hasten or bring about exflagellation? Yes. On this point, I think all are agreed.

Although in this paper I had intended dealing with the observed facts and omitting theories, or reference to deductions that were not obvious from an examination of the facts, I may add a few questions that might lead us across the border line between observed facts and theories, but I shall leave the answers for future consideration.

14. Phagocytes vigorously attack spheres—especially the males (flagella bodies). Is it likely that a cell which performs a function of this kind *in vitro* has not a similar function to perform inside the body?

15. If crescents are reduced in number, and if they are not eaten up by phagocytes, how is their reduction in number to be accounted for unless they change into some form which is likely to be attacked by the phagocyte ?

16. Is it possible that there is some method of breaking up other than that which is noticed *in vitro*—exflagellation in the case of the males, vacuolation in the case of the females ?

17. Would such a breaking up explain the secondary fever ?

While admitting that there are exceptions, we may sum up the main conclusions in regard to the Malignant Tertian fever as follows :—

(1). There is a Primary fever when Ring forms are found.

(2). There is an apyretic interval, when Crescents, that do not readily turn into the spherical forms, are seen.

(3). There is a Secondary fever, and the parasites found in the blood in this part of the fever are very different from those found in the Primary fever. In the Primary fever we find the asexual parasites, whereas in the Secondary fever the sexual parasites (gametes) chiefly are seen.

(4). Crescents begin to appear about the 8th or 9th day.

(5). The newly-formed crescents do not readily become converted into spheres.

(6). There is a period of maximum number of Crescents (Max. C). This occurs from the 12th to the 15th day.

(7). Towards the end of the gamete period the crescents diminish considerably in numbers.

(8). The spheres appear a few days after the Crescents, and generally about the 11th day.

(9). The number of spheres is at first small, but afterwards increases.

(10). There is a period of maximum number of spheres (Max. S.) and this occurs near about the 16th day.

(11). The period of maximum number of spheres follows the period of maximum number of crescents.

(12). After the period of maximum number of spheres the number of spheres diminish, and at the end of the gamete period only comparatively few are found.

(13). The period of Max. S. coincides in a remarkable way with the Secondary fever.

(14). Rings are not usually found in the blood in the Secondary fever.
(NOTE.—*A separate paper will be written on some cases that are exceptions to this rule.*)

(15). There is no doubt that the withdrawal of the blood from the body hastens or brings about exflagellation.

(16). Phagocytes will never attack Crescents *in vitro*.

(17). The gametes are in some way destroyed inside the body.

(18). The absence of Rings in so many cases in the Secondary fever, and the close relation between the period of Max. S. and the Secondary fever, the fact that Crescents and Spheres are reduced in number after the Secondary fever show that the Secondary fever is probably in some way related to the breaking up of the gametes inside the body.

(19). The actual nature of the process of breaking up is not yet known.

CASES IN DETAIL.

In order to study the cases they may be divided into groups, and the first group will include those that show the Primary fever, the Crescent interval, and the Flagellar fever, but in which there was no Third fever.

It has been already explained how the temperatures are shown. The abstract at the foot of each record shows at a glance the total number of parasites of the different kinds that were found in each period.

GROUP I.

Case (1), No. 759, Tukia.—Note the following points:—The primary fever is a clear tertian; the highest temperature on 4th day : on the 10th day crescents appear, ring forms have disappeared; spheres have not yet appeared, but appear three days later ; in the 1st sub-period of the flagellar period crescents are about double the spheres in number, and in the second sub-period spheres about double the number of crescents. Exflagellation at its maximum on 16th to 18th, and about this time flagellar fever : no ring forms found at this time.

Case 1. **Five minutes examination**

No. 759 Tukia.

Day of fever	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Degrees of fever	1	o	4	o	3	o	3	o	o	o	o	o	o	o	1	o	2	2	o	o	o	o	o	o	o	o	o
		Primary fever.							*Crescent interval.*			*Flagellar period*															
Rings	3	4	3	5	4	5	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crescents.	0	0	0	0	0	0	0	0	2	3	3	4	2	3	2	2	1	2	1	1	0	0	0	1	0	1	1
Spheres.	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	2	3	1	1	1	2	2	1	1	2	1	1

ABSTRACT...	*Rings* ...30	0	0	0	0
	Crescents ...0	8	9	5	4
	Spheres... 0	0	4	8	3
					0
					3
					10

Case (2), *No. 712, Shrawan.*—Primary fever not of tertian character ; crescent interval with no ring forms ; flagellar period with no ring forms ; relation of crescents to spheres similar to that in preceding case ; exflagellation at its maximum on 15th and 17th, and secondary fever highest on 14th and 16th; Quinine was given on and after the 17th day, and it probably checks exflagellation.

Case 2. *No. 712 Shrawan.* **Five minutes examination**

Day of fever ...	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Degrees of fever ...	1	3	3	5	5	3	o	o	o	2	4	5	o	4	o	o	o	o	o
	Primary fever.						*Crescent interval.*			*Flagellar period*						*	*		*
Rings ...	12	17	15	16	19	17	0	0	0	0	0	0	0	0	0	0	0	0	0
Crescents ...	0	0	0	0	0	0	5	7	9	12	10	7	7	4	3	2	2	1	1
Spheres ...	0	0	0	0	0	0	0	0	1	3	4	6	8	7	9	3	0	0	0

ABSTRACT	*Rings* ...	*96*	*0*	*0*	*0*	*0*	*0*
	Crescents ...	*0*	*21*	*29*	*14*	*5*	*1*
	Spheres ...	*0*	*1*	*13*	*24*	3	*0*

* Quinine grs. xx.

Case (3), No. 652, Vithoba.—Quinine (ten grains) was given to this case on the 6th day as it was rather a bad case; but it nevertheless shows some of the main points—maximum number of Rings on the 4th day, maximum fever on 3rd and 5th days, the crescents in the majority in the first sub-period, and the spheres in the second sub-period when the slight secondary fever appeared, absence of rings in the crescent interval and flagellar period.

Case 3. *No. 652 Vithoba.* **Five minutes examination**

Day of fever ...	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Degrees of fever ...	**2**	**6**	**7**	**6**	**7**	o	o	o	o	o	o	o	o	o	o	o	o	**2**	o	o	o
		Primary fever.								*Crescent interval.*				*Flagellar period*							
Rings ...	7	9	6	13	6	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crescents ...	0	0	0	0	0	0	0	0	0	0	0	1	3	3	4	3	3	2	0	1	1
Spheres ...	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	4	4	2	1	1	1

ABSTRACT.				
Rings ...	*45*	*0*	*0*	*0*	*0*
Crescents ...	*0*	*4*	*10*	*5*	*2*
Spheres ...	*0*	*0*	*7*	*7*	*2*

• Quinine grs. x.

Case (4), *No. 268, Karim Khan*—In this case quinine was given on the 13th day, but it shows the gradual rise of temperature till the fourth day and the ring forms attaining their maximum on the same day; absence of ring forms in the crescent interval, the crescents about double the number of the spheres in the first sub-period of the flagellar period; but in the second sub-period there is an alteration due to the quinine, and here again one dose of quinine seems to check exflagellation; exflagellation was at its maximum on the 13th day, and the Secondary fever was highest on the 12th and 13th days.

Case 4. *No. 268 Karim Khan* **Five minutes examination**

Day of fever ...	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Degrees of fever ...	**2**	o	**3**	**4**	**3**	**1**	o	**2**	o	**1**	**1**	**4**	**4**	o	o	o	o	**1**	o	o	o
			Primary fever						*Crescent interval.*		*Flagellar period*										
Rings ...	5	7	11	13	12	11	10	4	0	0	0	0	0	0	0	0	0	0	0	0	0
Crescents ...	0	0	0	0	0	0	0	1	5	7	9	9	6	7	6	3	2	1	2	1	1
Spheres ...	0	0	0	0	0	0	0	0	0	0	3	5	6	2	0	0	0	0	0	0	0

ABSTRACT ...				
Rings ...	*73*	*0*	*0*	*0*	*0*
Crescents ...	*1*	*12*	*24*	*16*	*5*	*2*
Spheres ...	*0*	*0*	*14*	*2*	*0*	*0*

*Quinine grs. xx.

The next two cases were only under observation for 13 and 16 days respectively.

Case (5), No. 7609, Abdul Razak.—In the Primary fever the temperature attaining its maximum on the 4th day and the number of ring forms attaining their maximum on the 5th day; crescents appearing on the 9th day; secondary fever beginning on the 12th day.

Case 5. *No. 7609 Abdul Razak.*

Day of fever ...		2	3	4	5	6	7	8	9	10	11	12	13					
Degrees of fever ...		**5**	**4**	**6**	**5**	**5**	0	0	0	0	0	**4**						
		Primary fever.							*Crescent interval*				**Released**	*Flagellar period*				
Rings ...		5	6	9	12	8	8	7	4	1	0	0						
Crescents ...									1	5	6	10						
Spheres ...										1	3	3						
ABSTRACT ...	*Rings* ... 55								*5*			*0*						
	Crescents ... 0								*12*			*10*						
	Spheres ... 0								*4*			*3*						

Case (6), No. 8063, Wali Mahomed.—This man had been in hospital and had received twenty grains of quinine on three successive days to stop Benign Tertian from which he had been suffering. The Malignant Tertian fever appeared 5 days later, but the number of ring parasites found was not largest when the temperature was highest; but here it should be explained that there is often a variation in the number of parasites according to the time of the day; and if the blood examination had been made about the time of sporulation, the number of parasites found in the peripheral blood would be small.

Case 6. *No. 8063 Wali Mahomed.*

Day of fever ..	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16			
Degrees of fever ...	0	**4**	**2**	**5**	**2**	**3**	**2**	0	0	0	0	0	**1**	**2**	0	0			
		Primary fever.							*Crescent interval.*					*Flagellar period*			**Released**		
Rings ...	6	6	2	2	2	0	1	0	0	0	0	0	0	0	0	0			
Crescents ...	0	0	0	0	0	3	2	4	6	10	12	13	14	19	25	26			
Spheres ...	0	0	0	0	0	0	0	0	0	0	0	2	2	3	8	10			
ABSTRACT ...	*Rings* ... 19								*0*			*0*			*0*				
	Crescents ... 9								*28*			*46*			*51*				
	Spheres ... 0								*0*			*7*			*18*				

Group II.

The Third fever.—We have spoken of the Primary fever and the Secondary fever; we shall now consider some cases in which the Third fever is seen. It is not always possible to distinguish between the Third fever and the Secondary fever, because they so often overlap each other; but the following case shows the Secondary fever distinct from the Third fever.

Case (7), No. 693, Nga Posin.—In the Primary fever the maximum number of rings were seen on the 6th day and the maximum fever occurred on the 5th day. Crescents appeared on the 8th day and spheres on the 11th. Crescents are double the number of spheres in the first sub-period, and the spheres are more than double the number of crescents in the second sub-period. Exflagellation was at its maximum on the 15th, and the secondary fever was present on the 13th, 14th and 15th. The Third fever period might be taken as beginning on the 21st day. Rings were absent from the 8th till the 19th day, and on the 21st day they are numerous. On the 21st the number of spheres was three times as great as the number of crescents, and after that date no more crescents were seen. The crescents, we believe, must have been destroyed in some way inside the body. On the 22nd there were many ring forms and there was 6 degrees of fever; but note that on that day there were no spheres. This Third fever then, we take it, must have been due to the breaking up of the Rosette forms chiefly.

Case 7. *No. 693, Nga Posin.*

Day of fever ...	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Degrees of fever ...	**4**	o	**2**	o	**5**	**2**	**2**	o	o	o	o	o	**2**	**2**	**1**	o	o	o	o	o	**4**	**6**	o
	Primary fever.								*Crescent interval.*			*Flagellar period*										*	*
Rings ...	15	11	10	13	7	16	10	13	0	0	0	0	0	0	0	0	0	0	3	4	13	19	13
Crescents ...							0	2	10	15	11	18	15	10	3	3	4	4	8	3	3		
Spheres ...											3	5	7	8	12	7	7	5	5	6	9		

Abstract		Five minutes examination.	Ten minutes examination.				
	Rings ...	*95*	*0*	*0*	*0*	*7*	*45*
	Crescents ...	*2*	*36*	*43*	*10*	*15*	*3*
	Spheres ...	*0*	3	*20*	*26*	*16*	*9*

*Quinine grs. xx given.

All cases do not conform to the type given above, *e. g.*, take the three following cases in which exflagellation has been apparently delayed, and in which the Secondary fever seems to be overlapped by the Third fever when the rings again appear in the blood.

Case (8), No. 6190, Manya.—In the Primary fever temperature highest and ring forms most numerous on the 3rd day. The fever on the 15th, 16th and 18th may be partly secondary fever and partly Third fever.

Case 8. *No. 6190, Manya.*

Day of fever ...	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Degrees of fever ...	3	3	4	2	2	3	o	o	o	3	o	o	o	o	2	2	o	2	o	o	o	o	o
	Primary fever.						*Crescent interval*			*Flagellar period*													
Rings ...	5	7	7	6	6	5	0	0	0	0	0	0	0	0	0	2	3	4	3	0	1	1	0
Crescents ...							3	2	3	2	2	3	1	4	3	6	3	4	3	2	2	3	1
Spheres ...								2	3	1	5	3	2	3	3	9	13	6	3	1	1	1	0

ABSTRACT ...				
Rings ...	*36*	*0*	*0*	*0*	*9*	*5*
Crescents ...	*0*	*8*	*7*	*8*	*13*	*11*
Spheres ...	*0*	*5*	*9*	*8*	*28*	*6*

Case (9), No. 8108, Makya :—This case is very similar to the preceding one. The early appearance of crescents is probably accounted for by there being little or no fever in the early period of development of the Ring parasites. On the 16th, 18th and 20th there was some fever but both rings and spheres were found at this time.

Case 9 *No. 8108, Makya.*

Day of fever ...			3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Degrees of fever ...			3	2	o	o	o	o	2	o	o	o	o	o	o	2	o	3	o	3	o	o	o
			Primary fever			*Crescent interval*				*Flagellar period*													
Rings ...			10	9	0	0	0	0	0	0	0	0	0	0	2	3	10	10	5	7	8	5	4
Crescents ...						3	5	3	1	2	1	2	1	0	0	1	2	1	2	3	6	5	3
Spheres ...							2	1	2	2	2	0	1	1	1	5	2	5	3	5	6	3	3

ABSTRACT ...				
Rings ...19	*0*	*0*	*0*	*15*	*39*
Crescents ... 0	*11*	*4*	*3*	*3*	*20*
Spheres ... 0	3	*6*	*2*	*8*	*25*

Case (10), No. 788, Nanhia.—This case is in many respects like the preceding two cases. Two degrees of fever on the 18th and 19th and both rings and spheres were found. The enormous number of Ring forms found in the Primary fever was a special feature of this case. In the Primary fever as many as 369 were found, and in one day, in two slides examined five minutes each, 101 parasites were found. In one field 6 or 7 were found, and in one corpuscle as many as three parasites were found. The temperature was up to 105 on one day, a very unusual temperature in Malignant Tertian fever, and it is worth noticing that the only other case in which very large number of parasites were found was a case in which there was a temperature of 104·8. In this case a special note of a curious form of parasite which we may, for the present, call a vacuolating female, and which will be described in a separate paper,* was made.

Case 10. *No. 788, Nanhia.*

Day of fever	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Degrees of fever	1	5	7	4	6	4	4	2	0	2	0	0	0	0	2	0	2	2	0	0	0	0	0	0
		Primary fever.						Crescent interval.		*Flagellar period*														
Rings ...	75	101	50	64	35	27	17	13	0	0	0	0	0	0	5	0	11	16	9	2	8	4	9	6
Crescents ...								5	13	13	13	22	32	27	21	28	15	15	8	17	14	6	9	12
Spheres ...									2	7	7	11	18	26	17	20	31	19	12	14	8	13	8	14
Vacuolating females ...														2	5	3	6	4	7	5	3	0	1	2

ABSTRACT ...					
Rings ... 369	*13*	*0*	*5*	*27*	*38*
Crescents ... 0	*18*	*48*	*80*	*58*	*66*
Spheres ... 0	*2*	*25*	*61*	*70*	*69*
Vacuolating females ... 0	*0*	*0*	*7*	*13*	*18*

Case (11), No. 201, Gujia.—This case is remarkable for the large number of parasites found in the Primary fever and for the high temperature 104·8. As in the preceding case, there was a rise of temperature every day. Maximum number of parasites on the 4th ; highest temperature on 6th day ; exflagellation at its maximum on the 19th day and the second Fever highest on that day ; but ring forms had again appeared.

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Case 11. *No. 201, Gujia*

Day of fever ...	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Degrees of fever ...	4	6	4	5	6	5	3	4	3	o	o	o	o	o	2	3	3	4	2	2	1	o	2
	Primary fever.							*Crescent interval.*			*Flagellar period*												
Rings ...	50	65	63	41	30	20	16	17	5	7	6	2	0	0	0	0	0	6	7	3	2	1	2
Crescents ...								2	15	20	22	15	10	8	10	15	12	7	15	10	5	3	5
Spheres ...									2	5	3	2	1	2	3	3	5	6	3	5	2	2	1

ABSTRACT ...					
Rings ... *285*	*29*	*8*	*0*	*13*	*8*
Crescents ... *0*	*37*	*47*	*33*	*34*	*23*
Spheres ... *0*	*7*	*6*	*8*	*14*	*10*

Case (12), No. 7795, Atumkhan.—Maximum Rings and Maximum Ring fever on 6th day ; crescent interval fairly distinct ; exflagellation at its maximum on 14th and 18th and fever highest on those days.

This case differs from the type in the following points :—the early reappearance of the rings, and secondly the unusually severe fever in the flagellar period. A second infection with its Primary fever corresponding with the flagellar period of the first infection might explain these variations from the type.

No. 7795, Atumkhan

Case 12.

Day of fever...	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Degrees of fever.	3	5	5	3	5	6	4	3	o	o	o	o	4	6	5	3	4	7	2	3	o	o	o	o	o
	Primary fever.								*Crescent interval.*			*Flagellar period*													
Rings ...	5	7	13	17	11	24	23	19	0	0	2	0	16	19	18	7	5	0	4	7	7	1	0	3	5
Crescents...									2	7	11	8	15	13	5	8	5	15	8	6	3	5	5	5	3
Spheres ...											2	3	11	15	11	4	3	9	8	3	2	5	4	5	1

ABSTRACT					
Rings ... *119*	*2*	*35*	*30*	*11*	*16*
Crescents ... *0*	*20*	*36*	*18*	*29*	*21*
Spheres ... *0*	*2*	*29*	*18*	*20*	*17*

Case (13), No. 602, Faiz Khan—This is a curious and exceptional case. If it is a single infection, rings have continued for a long time—15 days from the date of admission—and on the 16th day they are more numerous than they were during the first week. How can this be explained ? If there was a second infection with its Primary fever beginning on the 8th or 9th day this might probably explain the atypical nature of this case.

Case 13. *No. 602, Faiz Khan*

Day of fever ...	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
Degrees of fever ...	**5**	**2**	**2**	o	**1**	o	**2**	**3**	**3**	**4**	**2**	**3**	**3**	**2**	o	o	o	o	o	o	o	o	**1**	o	o	o	**7**	
	Primary fever.						*Crescent interval*		*Flagellar period*																			
Rings ...	2	1	1	2	0	2	3	2	2	2	2	4	16	6	4	0	0	0	0	0	0	0	0	0	0	0	0	0
Crescents ...					2	13	10	15	11	13	24	17	9	11	11	15	15	13	8	16	8	15	6	3	4	5	12	5
Spheres.						4	5	2	1	2	8	21	24	19	7	1	12	5	8	8	4	4	10	5	12	6	13	13

ABSTRACT.					
Rings... 8	5	6	26	4	0
Crescents. 15	25	48	37	41	95
Spheres... 4	7	11	64	20	88

DR. CHRISTOPHERS remarked that Major Buchanan's charts and parasite counts had shown the course of a malignant tertian infection to be a definite one. He was extremely interested to note Major Buchanan's observation that a secondary rise of temperature almost invariably takes place some days after the deferverscence of the fever. Also that crescents for three or four days after their first appearance in the peripheral blood do not change into spherical bodies or flagellates but do so after this period. The period during which large numbers of spherical bodies are present was also very striking.

What the nature of the secondary rise of temperature may be did not seem very certain. The observation that exflagellation forms occur in numbers at this time was very interesting, and a series of cases in which fresh and dried films were compared would probably make the relation of the two apparent.

CAPTAIN GLEN LISTON, I. M. S., said :—

I think that apart from theories Major Buchanan's work is of great importance. He has shown that for a time ring forms alone are found in the blood of malignant tertian fevers, that about the 9th day young crescents are found, that later the mature gamete is most abundant, and that at this time fever generally occurs, Still later the gametes disappear, and the fever also comes to an end.

He plainly shows that the secondary fever is due to the presence of mature gametes. This is all the more important when it is considered that some writers had expressed the opinion that gametes do not play any part in the production of relapses.

I would like to draw attention to some facts that appear to support Major Buchanan's statement apart from an actual count of the different forms of parasite present during the pyrexial and apyrexial periods.

Ko Tha Aung has shown us a beautiful specimen of a flagellating gamete. The specimen was stained by Romanowsky's method and showed clearly that those bodies which are sometimes called "polar globules" are the remains of the red blood corpuscle in which the crescent before it assumed the spherical form was enclosed. We know that these " polar globules" appear just at the time when the gamete assumes the spherical form. It will be clear, then, that the crescent on assuming the round form appears to escape from the red blood corpuscle in which it was till this time enclosed as in a skin. It is for this reason I presume that the phagocytes in a fresh specimen so readily engulf a spherical gamete and fail to attack a crescent body. Let us consider now what occurs in the primary fever. Just when sporulation is occurring fever comes on, in other words it is just when the parasites are liberated from the red blood cells and are free in the blood that fever is as a rule present. It is just so in the secondary " flagella" or gamete fever, it is when the crescents are changing into spherical bodies—when they are in fact escaping from the red blood corpuscles that fever comes on. It may be urged that "flagella bodies" occur at times when there is no fever, but at these times it will be found that they are exceedingly few in number. They are so few in number that they cannot cause fever in the same way as during the incubation period of the fever we must presume that sporulation is going on yet no fever exists.

CAPTAIN BIRDWOOD said —

I take exception to the terms " Flagella period " and " Maximum period of exflagellation. " They both imply that flagellation takes place inside the blood. Secondary fever is said to come on at the maximum period of exflagellation,

distinctly implying that it is due to exflagellation in the blood. Whereas we have no proof at all that exflagellation goes on in the blood. A more suitable way of expressing it would be to say that Secondary fever comes on about the time of maximum maturity of the crescents. I should like to know to what cause does Major Buchanan attribute the secondary rise of fever.

MR. POWELL fully recognized that there were periods in which flagellation was more frequent and more easily observed than at other stages. He had personally found it useless to look for flagella during the first couple of days in which crescents appeared. He presumed it was due to the fact that the crescents were immature—too young—or as it were, had not reached "puberty." To Major Buchanan was due the credit of determining the period of maximum sexual activity.

Mr. Powell had in the past few weeks observed two cases of fresh malignant infection. In both, rings only were found for the first three days. Then three and four days with neither rings nor crescents, crescents from the eighth and ninth days respectively. Fever began again on the 12th and 14th days respectively. Rings, fewer than in the primary fever were again found, but in sufficient numbers to account for the fever. He observed no tendency of the crescents to become globular.

None of the crescents had become globular and the number of rings was quite sufficient to account for the fever.

Major Buchanan calls his cases No. 12 and No. 13 in which rings are numerous during the secondary fever, exceptions from the type. Mr. Powell would rather regard them as the type, and Major Buchanan's earlier cases in which rings were absent during the "secondary" fever, as exceptions and very unusual. It is possible that the Burmans eagerly counting the relative proportion of flagellating and non-flagellating crescents, might pass over the rings without noticing them. Mr. Powell had often in searching a specimen for plasmodia, entirely overlooked spirilla which were in every field. As Captain Lamb well put it—"one's eyes have to be "tuned" to the object one is searching for."

NOTE.—Since the Conference Dr. Powell had watched two other cases carefully and kept records of the number of parasites found. In these cases also the Rings had returned with the secondary fever.

MAJOR BUCHANAN remarked in reply that there is still a good deal to be said in regard to what determines the return of the Rings. Although the counts given in the tables in his paper had been made from moist films, dry films had frequently

been taken. The possibility of the Burmans allowing the Rings to pass undetected had occurred to him, but he had observed himself the complete or almost complete absence of Rings in several cases when the Secondary fever came on.

He was sorry he could not show the Members a case as it was so late in the season, but one case had come to Hospital shortly after Dr. Christophers's arrival. Dr. Christophers had seen moist films taken from this case daily, and had also taken a series of dry films. He had been hoping that Dr. Christophers would have been able to complete the counts before the Meeting took place, but no doubt these would come later. The counts made in this case by Hospital Assistant Kesheo Rao and by some of the Burmans were as follows :—

December 1901 *No. 821 Jairam*

Date	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Day of fever...	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Degrees of fever ...	1	o	o	o	5	o	5	o	o	o	2	1	o	o	o	o	o	o	o	o	o	o	o	o	o
	Primary fever.							*Crescent interval*					*Flagellar period*												
Rings ...	7	2	3	3	6	7	6	0	0	0	0	0	0	2	1	3	1	0	0	0	0	0	0	0	0
Crescents...							1	5	17	16	21	22	15	11	7	8	8	4	7	4	0	3	5	2	1
Spheres ...									4	8	8	24	17	8	3	6	3	3	5	3	2	2	3	3	2

ABSTRACT.					
Rings ... 34	*0*	*0*	*6*	*1*	*0*
Crescents ... 1	*38*	*58*	*26*	*19*	*15*
Spheres ... 0	*12*	*49*	*17*	*11*	*15*

If however there is still any doubt regarding the relationship between the period of maximum spheres and the secondary fever, the point can easily be settled by taking a series of dry films and sending them to any one who would wish to test the truth of this observation.

As regards Captain Birdwood's objection to the use of the terms "flagellar fever," and the "period of maximum exflagellation," he would not quarrel. The observed facts in regard to Malignant Tertian fever seemed to him to be of such great interest that he was prepared to accept any name, provided that the question of names drew their attention to, not away from the facts that have been observed.

Captain Birdwood suggests that it would be a more suitable way of expressing it if we say that the Secondary fever comes on at the time of "maximum maturity of crescents." He had no objection to the use of the term.

With regard to the cause of the secondary rise of temperature, he would be inclined to agree with the explanation given by Captain Liston. Of course the secondary fever in those cases in which Rings are found again is probably due to the breaking up of rosettes, but he was referring to the secondary fever in those cases in which Rings are not found in appreciable numbers during the Secondary fever.

VALUE OF THE SPLEEN TEST AS AN INDICATION OF THE PREVALENCE OF MALARIA

BY

CAPTAIN S. P. JAMES, I. M. S.

Captain James stated that the work on which his paper was based had been carried out in conjunction with Dr. J. W. W. Stephens and Dr. S. R. Christophers, the Commissioners of the Royal Society.

He mentioned first the different ways by which the prevalence of malaria and the liability to infection in any district may be studied, *viz.*:—

(i.) By an examination of the statistics of admissions into hospitals for malaria.

(ii.) By an estimation of the prevalence of enlargement of the spleen among the general population.

(iii.) By the examination of blood films from a number of people of the general population, to ascertain the percentage infected with malaria parasites.

He drew attention to the value of the third of these methods, and especially to the value of the examination of films of blood from young children. The discovery of the fact that in malarious places a large percentage of the young children are infected with malaria parasites, even although they appear to be perfectly healthy, and that they are consequently the chief source of infection, is perhaps the most important advance that has been made in our knowledge of

malaria in tropical countries for several years. This discovery was made independently at about the same time by Koch in German East Africa and by Drs. Stephens and Christophers on the West Coast. The two latter observers and Captain James have found that with regard to the infection of native children, the facts which held good for Africa, apply in the same manner to India, and that in very malarious districts of India a large percentage of children are infected with malaria parasites, and in places where there is little or no malaria few or none of the children have parasites in their blood.

We have thus in this discovery an accurate test with which we can compare the results of our spleen counts.

Previous to this, the only means of ascertaining what value could be applied to the spleen test as an indication of the prevalence of malaria was by comparing the results of a spleen count with the statistics of admissions into hospital, and Captain James cited examples to show that the number of admissions into hospital cannot be relied upon in any way as an indication of the amount of malaria existing in a district or among a body of people.

At Mean Mir, for example, on November 29th, the hospital statistics showed that only 10 or 12 men of the Royal Artillery were under treatment for malaria. On that day blood films were taken from 96 men of this regiment, and examined by Dr. Christophers and Captain James. The results showed that 25 per cent of the men of the Royal Artillery had malaria parasites in their blood, so that if we assume that the strength of this regiment at Mean Mir was 400, the true number suffering from malaria would be 100 instead of 10 or 12.

Captain James then referred to the work which had been done since he joined the Royal Society's Commission, and divided it under the headings of the examination of adults and the examination of children.

From the examination of a large number of cases the conclusion was arrived at, that adults with enlarged spleens, unless they have a definite attack of fever, rarely or never show parasites in the peripheral circulation, so that from the estimation of the percentage of adults with enlarged spleens nothing can be inferred regarding the liability to infection, and the real prevalence of malaria at the time of examination,—which of course is the object desired.

In children with enlarged spleens, however, parasites are commonly found, and a relation exists between the enlarged spleen rate of children and the parasite rate of children in any place.

The following are some of the figures on this point at different places visited by Drs. Stephens and Christophers and Captain James :—

Table to show the relation between the endemicity of malaria and the percentage of enlarged spleens.

Locality.	Endemicity.	Spleen rate.
Calcutta	0 per cent.	0 per cent.
Jalpaiguri	16·1 „	17·7 „
Mainiguri	25 „	74 „
Rungamutty	43 „	82 „
Naigaisurie	55 „	83 „
Mean Mir	45 „	75 „

No definite ratio between the endemicity and the spleen rate can be established, nor does the spleen rate give an accurate measure of the percentage of children who are infected with malaria parasites, but still it is evident that, especially for purposes of comparison of the prevalence of malaria in different places, an estimation of the percentage of children with enlarged spleens gives us a very fair indication of the amount of malaria and the liability to infection.

Captain James then gave instances to show that as the cold weather advances the parasite rate diminishes, and at the same time the spleen rate also decreases, so that even in the cold weather the same relation may be said to exist between the endemicity and the spleen rate as before.

This is shown in the following table :—

Place.	Locality.	Date.	Endemicity.	Spleen rate.
Mean Mir ...	Infantry Bazaar	October	50 per cent.	82 per cent.
	Do.	Novr.	22 per cent.	38 per cent.
Mean Mir ...	Artillery Bazaar	October	35 per cent.	75 per cent.
	Do.	December	29 per cent.	34 per cent.

It is important, therefore, in all estimations of spleen percentages, to note the season of the year at which they were taken; and if we wish to compare the prevalence of malaria of different places by the spleen test, the counts should be made as nearly as possible at the same time of year.

Captain James summed up his conclusions as follows :—

(1) The estimation of the percentage of adults with enlarged spleens is of no value as an indication of the amount of malaria and the liability to infection.

(2) The estimation of the percentage of young children with enlarged spleens gives a fair indication of the prevalence of malaria, and for purposes of comparison, (especially if in the estimations the age of the children and the time of year are noted), will prove a very useful and easily-applied test.

DR. CHRISTOPHERS was of opinion that as a rough test of the prevalence of malaria in a district, the spleen test proves to be very useful, especially if the age of the children and the time of year are taken into account. A map of India showing the percentages of enlarged spleens among the children in different districts would be of great service.

He stated that the children of well-to-do natives appeared to be somewhat less liable to suffer from enlarged spleens than those of the poorer classes, so that this factor had also to be taken into account when making the examinations.

COLONEL MCKAY referred to the difference in the prevalence of enlarged spleens at different times of year and stated that he had examined 100 children at Katunga School some time ago and found that 20 per cent had enlarged spleens. In December, however, the percentage (320 children examined) was only 7½ per cent.

MAJOR HENDLEY said that just before coming to the Conference he had examined the boys (6 to 12 years of age) of 4 schools of the tract that might be called the sub-Terai of the Northern Satpura Hills, a tract looked on as feverish distinctly. Each school had 40 to 60 boys and from 7 to 9 per cent enlarged spleens was what he found. The percentage was lower than what James, Christophers and McKay mentioned; it may be that the relation of malaria endemicity and enlarged spleen is not constant in different localities.

Mr. Basak, the Civil Medical Officer of Wardha, contributed the results of a systematic examination of children from a number of villages in his district. He had examined 1,134 children in all, and a summary of his results may be tabulated, thus :—

Age of children.	Number examined.	Number with enlarged spleens.	Percentage of enlarged spleens
0—1 year ...	439	10	2·2 per cent.
2—5 years ...	181	16	8·8 ,,
6—12 ,, ...	514	78	15·3 ,,

The variation in the number of enlarged spleen cases in different villages was very marked. Thus at Kawtha, out of 38 children under 12 years of age, 12 were found to be suffering from enlarged spleen—a percentage of 31·5 per cent. At Shaikapur, where 69 children were examined, the percentage of enlarged spleens was found to be 8·1 per cent, and at Khangaon none of the children examined had enlarged spleens.

It is evident, from these results, that the amount of malaria existing in these districts depends largely upon local conditions, and a study of these conditions, and especially a study of the different species of anopheles present in each place, their habits and breeding places, would probably yield interesting results.

SOME OBSERVATIONS REGARDING CRESCENTS.

BY

Major A. Buchanan, I. M. S.

Based on observations chiefly made by Ko Tha Aung.

Their Sex.

The crescent is the form which a Malignant Tertian parasite assumes about the 9th day of the fever. It is also found in the Quotidian fever, but the date of its appearance has not yet been worked out. We have elsewhere* described what we have called the crescents with a belly and pointed out that these are apparently young crescents that have not fully grown.

* (Malaria Parasites and Fevers by Major Buchanan).

In this paper we propose to deal chiefly with the question of the sex of Crescents and how to distinguish one sex from another. In various books and papers we find a description given of the method of distinguishing a male from a female, but we very often find that the males described by one writer are the females described by another.

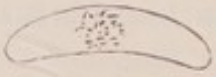
With a view to settling this point we directed our Burman observers to watch specially and see what is the appearance of the crescent which will subsequently give out flagella (the male) and what is the appearance of the one which will not give out flagella—(the female). After they had given attention to this point for some months, they were tested as follows:—A crescent would be put under the microscope and they would be asked to say whether it was a male or a female, and we found that Ko Tha Aung was able in almost every case to say whether flagella would be given out, though occasionally he might be doubtful

What then are the points by which we can distinguish the male from the female gametes—both before they change into the spherical shape and after they have changed into the spherical gametes ?

UNSTAINED CRESCENTS.

First, the unstained crescents : The chief point of difference between the male and female is in the arrangement of the pigment. In the male the pigment is more scattered about throughout the body of the crescent,

and in the female, the pigment is collected together into the central part—sometimes into a little clump without any vacant part in the centre



and sometimes with a central space free from pigment.

There is also a slight difference in the size of the pigment ; the pigment in the males is a little coarser.

STAINED CRESCENTS.

The females stain a slightly deeper blue. When stained with "Romanowsky" there is a slight difference in the chromatin.

Spheres.

When the crescents are converted into the round forms (spherical gametes) it is much easier to tell the male from the female. In the male before the flagella have been extruded the pigment is scattered about all over the sphere

while in the female we find an inner circle and outer circle, and the pigment is chiefly arranged at the circumference of the inner circle.

Two or three dark granules are seen in the space between the inner and outer circles and these are generally dancing about.

Female Spherical Gamete.

We have recently given a good deal of attention to the female spherica gamete and she has been the source of a considerable amount of discussion, and also some differences of opinion.

We had noticed in some Malignant Tertian cases—about the third week or later, a curious form of parasite which seemed to have a number of what looked like spores inside it

and although in a picture it may look like a rosette still the real parasite looks very different. The arrangement of the pigment led us to suspect that it was a female spherical gamete. For some weeks we wondered what this could be and asked many of those who are interested in Malaria if they had seen it. We considered the possibility of its being a sporulating form and as the first cases in which we found it happened to have the Ring forms again returning into the blood about the 20th day of the fever, we discussed the possibility of this curious form of parasite being a stage in the sexual reproduction of the parasites within the body.

A few days afterwards we were watching a female crescent and saw it change into the spherical form. After about half an hour it changed into the curious form referred to above and it seemed to be filled with what looked like spores; but occasionally two of these would join together and form one. We concluded then that they could not be spores and that they must be vacuoles; we were able to find these vacuolating females, as we now call them, often, and have shown them to several members of the Malaria Conference.

Since the above observations were made we have read the excellent paper, that appeared in the Malaria Number of *The Practitioner*, by Dr. Sambon and were much interested to find that the Italians had already experienced similar difficulties. Some described these bodies as "sporulating crescents," but later Marchiafava and Celli were of opinion that they are vacuolating spherical gametes.

After Ko Tha Aung had been working at this point for some time a letter was received from Major Ross in which he gave a description and illustrations of the males and females in the crescentic and spherical forms. The illustrations given by him of the crescents and spheres are very much the same as we have given here.

NOMENCLATURE OF MALARIAL FEVERS.

BY

MAJOR GRANT, I. M. S.

MAJOR GRANT pointed out that the classification adopted in the last edition of "*The Nomenclature of Diseases*," the use of which is binding in all official returns in India, is a daily source of dissatisfaction to hundreds of medical officers. Major W. J. Buchanan of Calcutta had written on the subject in *The Practitioner*, and the speaker himself had written upon it in the Annual Reports of the Government General Hospital, Madras, for 1897 and 1898.

In the present state of our knowledge it would not be possible in official returns to classify Malarial fevers into Quartan, Tertian, &c., but clinically, however, malaria cases divided themselves roughly into two great groups, viz. :—

(*a*) those characterised essentially by fever,

(*b*) those in which there might not be fever at any given time, but which presented in varying degrees the condition so long known, and on the whole satisfactorily, as Malaria Cachexia. It is a well-known fact that

in some districts in India malaria fevers may be abundant, and pronounced cases of Cachexia few, relatively speaking; while in other places the exact opposite is the case and in yet other places the proportions are more nearly equal. It is highly important, for reasons which could not be discussed here, to be able to distinguish their localities. At a later date it should be possible to correlate the different parasites with the clinical phenomena of the diseases to which each gives rise. At present this is impossible and we must be content with the division suggested in the draft resolution.

With regard to diseases or whatever they should be called, such as malarial neuritis, asthma, &c., the course and the only plausible one, would remain as before, *i. e.*, to return the primary disease as Malaria, and the secondary one in its proper place under the nervous system, respiratory system, &c.

Major Grant then read the draft resolutions, which had been drawn up by Major Roberts and himself.

(*Note.*—These resolutions were passed after some discussion, see page 138.)

Mr. Powell while agreeing that the present Nomenclature was unsatisfactory, considered Major Grant's proposed alteration not much better. Major Grant's classification assumed that all malarial manifestations came under the head of either "Fever" or "Cachexia." We frequently admit patients to hospital for malarial enlargement of the spleen in which there is no cachexia, and no fever. Are all the children with large spleens we see playing about the streets, as merry as crickets, "cachectic"? Mr. Powell can recollect recent cases of thrombus, of profuse sweating of the hand, of amblyopia and of aphasia associated with and in his opinion due to malaria parasites in which there was neither fever nor cachexia while in hospital. He would like the Nomenclature to recognise the accidents and sequelæ of malaria.

QUARTAN FEVER.

BY

Major A. Buchanan, I. M. S.

There happened to be three Quartan cases in Hospital at the time, each of which was getting fever on different days, so with the assistance of Captain Lamb and Dr. Christophers a series of specimens were put under the microscopes, illustrating the various stages of the Quartan parasites. Stained specimens were also put under the microscopes. Some of these had been stained by the Romanowsky method and some by the ordinary eosine and methylene blue.

Major Buchanan showed a number of charts which illustrated the persistence of Quartan, its regularity of day, and the effect of quinine and methylene blue. Other charts were shown to illustrate the absence of any benefit from the administration of arsenic. Some charts were shown to illustrate *severe* Quartan in which fever occurs every day, and it was pointed out how in such cases the temperature chart, if made from a morning and evening record of temperature, might be misleading. Some charts were shown to illustrate a combination of Quartan with other diseases. Two charts showed a combination of Quartan with Malignant Tertian, and in both the Quartan fever which was slight at first showed up more distinctly after the Malignant Tertian parasites had disappeared.

One chart was shown in which after a few Quartan paroxysms there was a gradual rise of temperature at the beginning of an attack of Typhoid fever. The Quartan rise of temperature could be distinctly seen in the early part of the Typhoid, but disappeared later on.

Two charts were shown to illustrate the combination of Quartan with Pneumonia, and here the Quartan appearance of the chart was at once lost.

A number of charts were then shown to illustrate the Quartan fever of sparrows in which the Halteridium can always be found in the blood. A comparison was made between the Quartan parasites of man and the differences were then pointed out. In the sparrow it is very common to find Flagella bodies, but it is rare to find the flagella in human Quartan. The question was then asked—why is it that Quartan which is so persistent is so comparatively rare? There may be two possible explanations,—one, the fact that flagella are so rarely seen in Quartans, and the other that possibly there may be some special kind of mosquito which conveys Quartan. It has usually been in the cold weather months that Quartans have been found and in the Autumn time when the two Tertians are most prevalent the Quartans are very rare. He had been trying to find whether there is a definite time for exflagellation in Quartans, but up to the present he is unable to say what are the circumstances which determine exflagellation.

DR. POWELL said that Quartan was rare in Cachar, and that out of 400 cases he saw only one Quartan.

DR. CHRISTOPHERS said that in the Duars, Quartan is the commonest. The Quartans often have scanty infections and consequently they may escape notice.

Mr. Aitken (E. H. A.) suggested that the different seasonal incidence of the Quartan may possibly be due to the mosquito which carries on its breeding at a different time of the year. He would recommend the collectors of mosquitoes to put the date when the mosquito was found on the specimen so that it may be possible to say whether one kind of anopheles may breed in one season and another at another time of the year.

BENIGN TERTIAN FEVER.

BY

Major A. Buchanan, I. M. S.

A series of charts were shown to illustrate the nature of the Benign Tertian fever. In one man who had been working in the Laboratory, Benign Tertian parasites could be found almost at any time throughout a whole year. Once or twice a month he would get a slight rise of fever for a day or two; but it did not affect him seriously, for his weight went up several pounds.

Some cases were mentioned to illustrate the value of diagnosis with the aid of the microscope. Mr. H. (Indian Civil Service) had a severe fall from a trap a year before and sustained a serious injury to his spine. Many months afterwards he complained of pain in the lower part of his spine, and loss of sensation in the inner side of the sole of his foot (4th lumbar nerve area). He had occasional attacks of fever and thought that possibly the fever might be due to spinal inflammation. If that were so, it would have been necessary to recommend his being sent home to England. However, after finding Benign Tertian parasites a few doses of quinine stopped the fever, and the case assumed a much less serious aspect.

Mr. M., another Civil Servant, had been suffering from fever occasionally for some months. He happened to visit Nagpur and had his blood examined. Result: Benign Tertian found : quinine given : fever stopped: no fever since.

Two ladies, who were pregnant, had Benign Tertian parasites in their blood. Both objected to take quinine owing to the discomfort which followed from the contraction of the uterus. A series of experiments were begun in the Jail in order to test the value of methylene blue, and finding that it was useful it was given to both cases referred to. A number of charts were shown to illustrate the effect of the methylene blue. The doses varied from 2 to 12 grains in the day. The effect was in most cases good, but not so good as that of quinine. An analysis of the cases will be made subsequently.

Blood containing Benign Tertian parasites had been injected into three volunteers. Result: a few parasites found a few days later in the blood of all three cases, but only one of these got fever, and the fever was slight (one degree for one day). At the same time blood with Benign Tertian parasites was injected into two monkeys. Result: no parasites found, although prolonged examinations were made.

Specimens to illustrate all the stages of Benign Tertian, stained and fresh, were shown under the microscopes by Captain Lamb and Dr. Christophers.

HINTS TO BEGINNERS WHEN SEARCHING FOR MALARIA PARASITES.

BY

MAJOR A. BUCHANAN, I. M. S.

Even the most skillful microscopists are liable sometimes to put the slide upside down and consequently the blood cannot be brought into focus. So always look twice to be sure that you have the right side up. When the specimen is an uncovered film on a slide, hold the slide out towards the light so that the light will fall on it in a slanting direction : the side with the specimen on it is dull while the other side is glossy.

2. When finding the focus with the oil immersion see what kind of cedar wood oil is used. Moderately thick oil is the best, but the oil which has been obtained recently is very thin, and instead of screwing down the fine adjustment after the lens has touched the oil, it is necessary to screw the microscope up from the glass. Better find focus while microscope is in a vertical position. If the oil is thin and the microscope in a sloping position the oil runs off the glass.

3. *Bubbles* : are easily recognised.

4. *Dust in the eye-piece* : This may often give an appearance of a ring form in a red blood corpuscle. Turn the eye-piece round and the dust moves with it.

5. *Blood dust lying on a corpuscle.* This may often give an appearance like a ring form. Touch the cover glass with a needle or pencil. The parasite moves with the corpuscle ; blood dust will be separated from it.

6. *Crenation* : When one of the spikes of a crenated corpuscle is on the upper side of the corpuscle, it may be mistaken for a Ring parasite, but the clear ring in the parasite will enable us to distinguish between the two.

7. *Vacuoles* : look like rings in the corpuscle : Alter the focus slightly : if the ring spreads out it is a vacuole.

8. *Cracks*: The corpuscles are sometimes broken, and a crack or tear in a corpuscle may be mistaken for a young parasite, but a parasite can be distinguished by its alteration in shape.

VARIOUS KINDS OF CELLS SEEN IN BLOOD.

Red blood corpuscles : Rarely very large ones called megalocytes are seen : sometimes small ones called microcytes are seen.

White blood corpuscles : Polymorphonuclear, (Phagocyte) Mononuclear large, Mononuclear small, (Lymphocyte), Eosinophile cell.

Blood dust and blood plates will often be seen.

(To clean Slides.)

Those that have been in use and have had vaseline smeared on them should be washed first with turpentine to take off the vaseline : then with soap and warm water: wipe and keep in alcohol.

MR. POWELL offered a few practical "hints" on the working of the Microscope.

Frequently in India one was unable to obtain thick Cedar oil. He had often used Castor oil instead and found it much preferable to the thin Cedar oil obtained in India. It is advisable to test the oil to see that it is not acid, lest it injure the brass of the eye-piece.

When many dry specimens have to be stained at a time, the best method of labelling is to make the end of the blood smear slightly thicker than the part to be examined. When dry, the name or number of the patient can readily be scratched on this thicker film with a blunt needle or a style.

It is claimed by some that " Schuffner's dots " are diagnostic of benign tertian parasites. This is far from correct. In many specimens of benign tertian, cells containing parasites may be seen side by side in the same field, some with—some without—Schuffner's dots. In other cases crescents may be seen in the same field with small ring-infected cells with marked Schuffner's dots. It may be claimed that these are cases of double infection—benign and malignant tertian—but examination on successive days has shown nothing but rings and crescents.

In a specimen of malignant tertian taken from the spleen to-day by Captain Lamb may be seen rings in cells with well-marked dots.

It was a pity to make a claim which could not be substantiated for so useful, certain, and beautiful a stain. He has never seen Schuffner's dots in Quartan cases.

ROMANOWSKY'S STAIN.

DEMONSTRATED BY CAPTAIN LAMB, I. M. S.

Fix for 10 minutes in absolute alcohol. Dry before putting on the stain.

I.	Eosine B. A, 0·1 per cent solution.		Heat for some time.
II.	Methylene blue (Medicinal pure)	1 part	
	Carbonate of Soda	0·5 „	
	Water	100 „	

(1) Take one CC of each solution and dilute with 25 CC of water in separate bottles.

(2) At the time required add 2 parts of dilute methylene blue solution to 3 parts of dilute eosine.

(3) Allow to act for half an hour.

(4) Wash well in running water.

SECTION III.

CONTINUED FEVERS.

THE DIAGNOSTIC VALUE OF THE BLOOD CHANGES, AND ESPECIALLY OF THE DIFFERENTIAL LEUCOCYTE COUNT, IN CONTINUED AND REMITTENT FEVERS.

By Leonard Rogers, M. D., M. R. C. P., I. M. S., *Offg. Professor of Pathology, Medical College, Calcutta.*

In bringing this subject before you I have to crave your kind indulgence on account of the very short notice at which this communication has been prepared. The question of the differentiation of tropical fevers is second to none in importance, but will require years of work. During the last few months advantage has been taken of the unrivalled material in the various hospitals of Calcutta to commence work at this subject. A careful examination of the blood, including the use of the serum tests, has been carried out in addition to the taking of clinical notes and the preparation of temperature charts, some fifty cases of continued and remittent fever having already been examined. Although only the fringe of the subject has yet been touched, yet certain results have been obtained, and I desire to take this opportunity to briefly summarise the main points.

Typhoid fever in Natives.

The most important result has been the establishment of the fact that so far are natives of India from being immune to typhoid fever, as maintained by Crombie and others, that the disease is really very common among them in Calcutta at the present time. As I am dealing at length with this part of the subject in another place[1] only a few remarks will be made with regard to it here. By means of the serum test no less than eleven cases of enteric fever in pure natives have been recognised within four months in the Medical College Hospital alone, complete reactions in a dilution of 1 in 100 having been obtained in ten of them, and of 1 in 40 in the remaining one. Two more cases have been also seen in other hospitals. The dilutions were made by means of Wright's method, and the reactions watched under the microscope, the time limit being one hour, fresh one day cultures being used and a control always made. In addition to these cases in pure natives, others have been seen in Eurasians, Armenians, Chinese and Goanese, so that no race appears to be immune. Clinically most of these cases showed great depression or delirium, or other symptoms of the so-called typhoid state, but similar symptoms were also met with in other fevers, such as pneumonias and in some malarial remittents, so that in the first week or two, at any rate, it is often impossible to differentiate them by the symptoms alone. On the other hand, in every case, except two which died in an earlier stage, the fever lasted

three weeks or upwards, and in the present limited series over 80 per cent. of the cases in which the fever lasted continuously for three weeks, or over, were typhoid cases. In most of the cases some tenderness in the abdomen, or more or less well marked tympanitis was noted. The reaction for Malta fever was also tested in most of this series of fever cases, including all doubtful ones, but no positive reaction was obtained, so that the disease is probably less common in Calcutta than in the Punjab.

Alteration in the Haemoglobin.

It is the differences between the changes in the blood in typhoid fever and in malarial remittents with which I have chiefly to deal, for in the earlier stages, when the serum reaction may be absent, and, owing to quinine nearly always having been taken, malaria parasites may be carefully searched for in vain, any points of difference will be of the greatest value. The following remarks are based on observations which have invariably been made by himself with the same instrument in every case so that the two series are strictly comparable, and I propose to briefly summarise the main points. I have shown elsewhere[2] that the anæmia produced by chronic malarial fever is of the pernicious type, the haemoglobin value being high. Allowance must be made for the fact that in the case of natives of India, the haemoglobin value (as worked out with Gower's instruments) is much lower than the European standard, averaging in healthy persons only about ·7. In typhoid fever cases the figure varies but little from the normal on either side, even in the later stages when some degree of anæmia is present. On the other hand, in malarial remittents it is often higher than normal, from ·8 to 1 or occasionally over. In some chronic cases, with large spleens however, it may be lower than normal, but these are not such as could be mistaken for typhoid, so that the high values are of most diagnostic import as an indication in favour of a malaria rather than of typhoid.

The red corpuscles.

A marked diminution of the red corpuscles such as to below 3,000,000 per cubic millimetre is seldom met with in uncomplicated typhoid, although not uncommon in malarial remittents.

The total number of white corpuscles.

The total number of white corpuscles per cubic millimetre is decreased in both diseases, so that frequently no guidance can be obtained from this count. The decrease, however, is often much more marked in malarial remittents than in typhoid, so that while it is unusual to find fewer than from 3,000 in typhoid, lower counts than these are frequently met with in malarial remittents, in which the number may even fall to about 1,000 or 2,000, and the proportion of white to red corpuscles may be as low as 1 to 2,000 or even lower. Such low counts point to malaria rather than to typhoid.

Variation in the different kinds of white blood corpuscles.

During the last few years much attention has been paid to the variations in the percentages of the different forms of white corpuscles in various fevers, and I have long desired to apply this method to tropical diseases. Recently Drs. Stephens and Christophers have shown that in malarial fevers, especially during the remissions of the temperature, the large mononuclear corpuscles are greatly increased. On the other hand, Turk gives counts in typhoid which show a great increase in the small mononuclear corpuscles (lymphocytes) without any increase in the large mononuclears. Cabot and Coles, however, state that in typhoid it is the large mononuclears which are chiefly increased. The point is evidently worthy of further consideration, and I may state at once that my observations agree with those of Turk that in typhoid it is the lymphocytes only which are increased while in malaria the characteristic change is an increase of the large mononuclears, although in the more chronic cases the lymphocytes are frequently also present in larger proportion than normal.

In normal blood.

The normal percentage of each variety is according to Cabot: polynuclears 62-70 per cent, lymphocytes 20-30 per cent, large mononuclears 4-8 per cent, and eosinophiles ½-4 per cent.

White corpuscles in Typhoid.

In typhoid during the second week, as a rule the proportion of lymphocytes rises to about 40 per cent., the polynuclears being correspondingly decreased, while in the third week and early convalescence the proportion of the small variety become still greater and may even reach 50 per cent. The large mononuclears in my experience vary within the normal limits only, with a tendency towards the lower rather than the higher limit, as is also seen in Turk's figures. The eosinophiles show no constant change, but are usually present in smaller numbers than usual.

White corpuscles in Malaria.

In Malaria the characteristic change is an increase of the large mononuclears to from about 12 to 20 or more rarely even 30 per cent. This change is most marked during the remissions of the fever as first pointed out by Stephens and Christophers. It may sometimes be absent during high fever, but in these cases I have found the total leucocyte count to be reduced to 1,000, or under, per cubic millimetre at such times as the large mononuclear increase is absent—an important point, as such an extreme reduction of the leucocytes I have never seen in typhoid. The small lymphocytes show little or no increase in acute cases without any anaemia, but in more chronic cases with secondary anaemia they may be greatly increased, and

may even reach a higher figure than in typhoid. The eosinophiles tend to be low, but this change is not very constant. Myelocytes may be present in malaria, and are, I think, of some diagnostic value as I have never found more than an occasional one in typhoid fever.

ILLUSTRATIVE CASES.

A Malarial Remittent mistaken for Typhoid.

Having now dealt with the changes in the blood observed in typhoid and malaria fevers, a few cases illustrative of the value of such data in the diagnosis of actual cases may be given, and finally the value of the presence of leucocytosis in excluding both typhoid and malaria and pointing to some other affection will be referred to. Two native Christian girls were admitted in the Medical College hospital within a few days of each other with continued fever, and there was a history of the recent death of another child from typhoid in the same house. The first showed well-marked symptoms of typhoid and gave a good serum reaction on the 13th day, subsequently suffering from a relapse and barely escaping with her life. The second had suffered much from fever a year before, and still showed some anæmia and marked enlargement of the spleen. The present attack of fever had begun five days before admission and was considered to be typhoid. An examination of the blood on the 12th day, when the temperature had fallen for the first time to normal, showed Haemoglobin 24%, Red corpuscles 2,165,000, and white 1,000 per cubic millimetre; the proportion of white to red was 1 to 2,165, and the serum reaction for both typhoid and Malta fever was negative. The degree of anæmia, and the very small proportion of white corpuscles made me at once suspect that the case was a malarial remittent, but no parasites could be found in the blood, quinine having been given. The diazo reaction was also absent on testing the urine and this was very strongly against a diagnosis of typhoid. On working out the differential leucocyte count, 39% of polynuclears, 42% of lymphocytes, 20% of large mononuclears, and 1% of eosinophiles were found, that is just the typical count of a malarial case with a large spleen, the abnormal proportion of large mononuclears serving to clinch the diagnosis of malaria. After an interval of a week without fever the temperature rose again and became continued once more, and clinically the case was again thought to be one of typhoid with a relapse. On re-examining the blood no malaria parasites could be found, but the figures were very similar to those just given, except that the large mononuclears now numbered 11·5 per cent, which was higher than I have ever met with in typhoid, and considering the height of the fever (105·2) was what might have been expected in malaria. The serum reaction also still gave a negative reaction for typhoid, and I again reported the case as one of malaria. Larger doses of quinine were given and the temperature fell and uninterrupted recovery followed. In this case it was chiefly the fact that the patient had come from the same house as another enteric case that gave rise to a suspicion of typhoid.

Bronchopneumonia versus *Typhoid*.

In another instance a man was admitted for fever and bronchitis, and as he was very dull and depressed, and had great headache and a dicrotic pulse, typhoid fever was also thought to be a not unlikely, diagnosis. On the sixth day of the fever a blood count showed over 8,333 white corpuscles per cubic millimetre, 81 per cent of which were polynuclears; while nine days later 15,750 leucocytes with 90 per cent polynuclears were found,—a definite leucocytosis, which together with a negative serum reaction and an absence of malaria parasites pointed to the case being one of simple bronchopneumonia with unusually well-marked "typhoid state."

Mild Typhoid overlooked in a Malarial subject.

The following case is of interest as an illustration of the value of blood examinations in preventing mild cases of typhoid being overlooked, especially in natives, in whom this fever is less liable to be suspected. A salt peon, who had suffered from repeated attacks of malarial fever in the Sunderbunds, was admitted for remittent fever, and as he also presented some degree of anæmia and marked enlargement of the spleen together with slight enlargement of the liver, I felt no doubt on first seeing him that he was suffering from a malarial remittent fever. An examination of the blood resulted as follows :—Haemoglobin 46 cent, red corpuscles 3,460,000, white 1,750 or 1 white to 1,977 red. These figures pointed to some degree, of anæmia due to malaria. On counting 500 leucocytes in a slide, made in the morning during a slight remission, I found 52% polynuclears, 40 lymphocytes, and only 6 large mononuclears. This count was that of typhoid and not that of malaria, the large mononuclears not showing the increase of the latter disease. On subsequently carrying out the serum test a positive reaction for enteric was obtained, and the failure of quinine in large and frequent doses to affect the fever, the continuance of the fever up to the 22nd day, when it fell by lysis, and the failure to find malaria parasites, all confirmed the verdict of the blood examination that the case was one of mild typhoid in a malarial subject. The importance of a correct diagnosis in such a case is two-fold: firstly, it is of advantage to the patient as greater care will be paid to his diet after the defervescence of the fever, which may save him from a relapse, and secondly it is an advantage to his neighbours as attention will be paid to the disinfection of his excretions, and one possible source of infection will be prevented.

Cerebrospinal Fever versus *Typhoid*.

Cerebrospinal fever in well-marked cases is usually an unmistakeable disease but sometimes on first admission typhoid may be suspected as in a case which I saw recently. In this case the presence of a high degree of leucocytosis excluded the latter disease.

Value of the Leucocyte Count in the Diagnosis of Malaria from Liver Abscess.

Of greater frequency and of much more importance are the cases of liver abscess, in which we so often find an intermittent fever that may be easily mistaken for malaria. I shall mention three cases:—

Case I.—A soldier had been sent to Calcutta from Darjeeling to be invalided home for what was thought to be malarial fever. While in Calcutta his Medical attendant noticed that there was some enlargement of, and some tenderness over the liver. The chart showed an intermittent fever precisely similar to that of a malarial case in the next bed. At the request of his Medical attendant I made an examination of the blood, and instead of finding the low number of white blood corpuscles which one would expect in malaria, I found that there were over 30,000 per cubic millimetre. Aspiration was performed on the same day, and an abscess was found and opened.

Case II.—In a second case aspiration had been performed but with a negative result. A few days later there was copious hæmorrhage from the bowel and I was asked to carry out the serum test for typhoid. The temperature chart was suggestive of malaria, but the search for parasites proved negative. The serum test for Typhoid also proved negative. There was however a very high degree of leucocytosis (38,500), and this pointed strongly to the original diagnosis of liver abscess being correct. The abscess was again sought for and on this occasion it was found.

Case III.—This patient was supposed to be suffering from malarial fever. No parasites were found, but little value could be attached to this negative result as quinine had been already given. He also had hæmorrhage from the bowels and on this account I was asked to test his blood. The serum test was negative, but 31,375 leucocytes per millimetre were counted. I suspected liver abscess. On further enquiry I learned that the liver had been enlarged and slightly tender, but the enlargement had gone down after the hæmorrhage from the bowel, this even having probably resulted from the opening of an abscess of the liver into the bowel.

In tropical climates any intermittent fever is liable to be considered malarial, for a time at any rate, but the above cases illustrate the value of blood examinations in the detection of the leucocytosis of deep-seated inflammations producing intermittent fever which may simulate malaria. Lastly, there is the very important, but difficult question of the occurrence, or not, of still undifferentiated continued fevers but I am as yet very far from being in a position to answer it. If such occur, they are not very common, but that is all that I can say at present.

References (1) *Indian Medical Gazette*, 190, page 6. (2) *Journal of Pathology and Bacteriology* 1899. (3) *Reports of the Royal Societies Malaria Commission.*

CAPTAIN LAMB said :—

I am sure that we have all to thank Captain Rogers for his most interesting and instructive paper. Personally, I have listened to it with great pleasure and interest, for the question of the continued fevers in India and especially the question of the prevalence of typhoid fever in natives of India are subjects which have occupied my attention for the last two years. I may say at once, then, that there is no doubt that Captain Rogers's paper is a valuable contribution and will help greatly in the elucidation of the problems now under discussion. Not many years ago, the occurrence of typhoid fever in natives was denied by clinicians. The view was supported by some observations of Freyer on the serum reaction of the blood of healthy natives. I have shown elsewhere (*Indian Medical Gazette*, April 1901) that these observations of Freyer are not reliable, and that in the serum sedimentation reaction we have a valuable aid for the differential diagnosis of the continued fevers of India. All my observations however have been made with dead bacterial emulsions. Working with these I have found that a *complete* sedimentation reaction with a 20-fold diluted serum is quite reliable to diagnose typhoid fever. But remember it must be complete. It is generally agreed among bacteriologists that the minimum dilution of serum which can be relied on for diagnostic purposes depends on whether a living or dead emulsion is used, on the number of bacteria present in the emulsions and on the virulence of the bacteria. As I have said, I have found that a 1 in 20 dilution with a dead emulsion, made always in the same way from a laboratory typhoid culture, can be relied on.

2. Working in this way I have found many cases of Typhoid fever in natives of India. The observations on some of these cases I have already published, and others will appear in the February Number of the *Indian Medical Gazette*. These observations are fully confirmed by Captain Rogers's results and bear out the opinion of some of the clinicians of the younger school, among whom I am pleased to find our friend Major Buchanan, that typhoid fever is by no means an uncommon disease among natives. I also agree with Captain Rogers that this disease is not confined to the lower class of natives, but that Hindus and Brahmins are affected as well. Thus in a series of 10 cases, which occurred at Poona and which were diagnosed by me as typhoid fever by means of the serum test, eight were high caste Hindus or Brahmins.

It would appear, then, that typhoid fever is really fairly common among natives in the bazaar and that therefore every bazaar is a source of danger to the neighbouring European settlements.

3. I have heard with great interest the value, for purposes of diagnosis, which Captain Rogers ascribes to the differential count of the white blood corpuscles. I have had no experience of this in the case of Malaria or in the case of typhoid fever, but I have found it of great value in cases of septicaemic diseases, such as spirillum fever, and in cases in which abscess formation was suspected. Thus I can remember two cases which illustrate this :—

While working at Netley I saw a patient in hospital who, from the symptoms present, was suspected to be suffering from typhoid fever. His serum however gave no reaction with the *bacillus typhosus* but a differential count of the white blood cells showed a great polynuclear leucocytosis (about 90 °/₀ of polynuclear cells). In spite of this hint the clinicians still stuck to their diagnosis of typhoid fever. The patient ultimately came to the post-mortem table. On opening the chest 40 ozs. of pus were got from the right pleural cavity. There were no signs of typhoid fever, and a culture taken from the spleen remained sterile.

The other case is still more interesting. I was asked not long ago to see a young European who had shortly before arrived from England. He was suspected to have a liver abscess. There was enlargement of the liver with much pain. The temperature showed a daily rise of from 2 to 3 degrees. A differential count of the leucocytes showed these to be normal. Two Surgeons had met with their trocars, &c., to puncture the liver. The result of the differential leucocytic count however induced them to hold their hand. The symptoms gradually improved and in a week or two the patient was sent home. It is nearly a year ago now since these events happened and no further developments have taken place. It would appear necessary therefore in all cases of fever, the diagnosis of which there is any doubt about, to make this differential count of the white blood cells.

4. In conclusion, I have a word to say as regards Captain Rogers's statement that he would consider every—or almost every—case of continued fever in India, which lasted for at least three weeks, to be a case of typhoid fever. This may be so; but the data which we have before us do certainly not warrant this sweeping conclusion. Captain Rogers has alluded to Malta fever as being very rare in Calcutta. Although it does occur, I think it is not common in Bombay. Thus I have put on record (*I. M. G.*, September 1900) three cases of this disease, while I have seen two other cases in Bombay which have not been recorded. I think that this disease is probably commoner in Northern India than it is down South. Thus several cases have been described as occurring in Mean Meer, in Simla and in the Swat Valley. These facts alone should certainly make us cautious in accepting Captain Rogers's statement. But I have further facts which go against it. Thus a year and a half ago I was travelling through the famine camps in Guzerat examining the wells for the cholera vibrio. In some of these camps fever was very common. This fever seemed to be of some duration but no records were kept and no data available. I examined the blood of about 200 of these cases, and I found neither spirilla nor malaria parasites. The symptoms were not those of typhoid or typhus fever as I could judge. Unfortunately I had orders not to delay, only to spend two or three days in each camp, and besides it was impossible to get any post-mortem examination. The question then as to the pathology of this epidemic fever in the Guzerat famine camps is still unsolved. This again shows us that we must be cautious.

But it is a great step in advance that we can now positively affirm that typhoid fever is a common disease among natives and it is encouraging to think that in the next few years much light will probably be shed on the other continued fevers, a subject which up to the present has been in a hopeless muddle.

Mr. Powell was surprised that Drs. Stephens and Christophers found benign, tertian and quartan parasites the most common in the Terai and Duars. In Southern Assam, another planting district where planters willingly took salaries a third less than they could get in the Duars, simply because the Duars was so unhealthy, Mr. Powell found the "malignant" parasites much more common than the benign forms. Yet *clinically* the fever of the Duars was infinitely more "malignant" than that of Assam. With seldom less than a hundred malarial cases in the hospitals daily, probably only two or three quartans would be met yearly. Intermittent—tertian fever—was the exception. Planters spoke of it as "fever *and* ague." The coolies called the prevalent summer-autumn malaria "bokhar," and had the distinctive name "Pahari bokhar" for the much rarer tertian.

Yet the majority of the planters who had left the Duars on account of their health and come under Mr. Powell's care had tertian parasites and fever.

It might be of interest to quote the results obtained in Bombay, chiefly among the Police force.

Of 401 consecutive cases whose blood was examined, there were			
Tertian	...	167	
*Double tertian	...	32	199
*Some of these were benign and malignant.			
Malignant rings or crescents	...		82
Quartan	...		1
Pigmented whites with no parasites seen	...		47
Total Malaria	...		329
Spirilla of Relapsing Fever	...		19
Blood negative	...		53
Of these negative cases subsequent events shewed :—			
Plague	...		7
Pneumonia	...		9
Pleurisy	...		3
Tubercle	...		6
Abscess, bursitis or bubo	...		5
Tonsillitis	...		1
Enteric	...		3
Jaundice Catarrhal (?)	...		1
Cause of fever unknown	...		18
Total	...		53

It should be observed that quinine had, as a rule, been given before the blood was taken. This accounts for so many negative cases.

Relapsing fever was very common in Bombay and had in the past eight months caused more deaths in the Police force than any other fever, plague included.

He met many cases with spirilla in which there was no relapse.

Also cases with a very typhus-like petechial eruption. The longer duration of typhus apart from the absence of spirilla made diagnosis easy.

Enteric was common among the natives. He had two at present under his care. Captain Lamb in both cases found sedimentation complete in 1—50; "distinct" in 1—100 dilution. His predecessor Dr. Sydney Smith had for many years back recorded cases of enteric among the Native police.

Anthrax he had repeatedly seen in horses and men in Assam. The men were Chamars who skinned the dead animals. Dr. D. Taylor had had cases of both malignant pustule and anthrax fever in men. The speaker had never recognised human anthrax without the pustule. It is probable he has mistaken cases of acute anthrax for double pneumonia and malaria.

Like Captain Rogers he also had lately quite a little epidemic of broncho-pneumonia. He had looked on it as influenzal in character.

He asked Captain Rogers with reference to his remark that all fevers of more than three weeks duration otherwise unexplainable, should be diagnosed as typhoid whether he recognised cases of "abortive" typhoid. Speaker met with many cases of fever in the South African campaign, lasting eight or ten days, with morning remissions and diarrhœa. It was impossible to tell whether such cases would get well in about eight days or go on through a typical enteric course.

As regards the leucocyte count, speaker had not given special attention to this point, but his experience was that he could give a diagnosis of "leucocytosis" to any healthy man by restricting the count to the edge of the blood smear. He found the proportion of mononuclears and polymorphonuclears varied greatly with the thickness of the film and whether the centre or the margin were examined.

He would be grateful to Captain Rogers if he would demonstrate some standard method which would eliminate the personal equation and allow one to compare the results of different observers.

CAPTAIN LISTON said:—

Shortly after coming to India, three years ago, I had an opportunity of seeing such a case as Dr. Powell refers to. The patient was a British soldier in the Station Hospital at Secunderabad. He was admitted with fever. His blood was examined for malaria but without result—his temperature remaining high and his general appearance suggesting typhoid fever. His blood was examined by Widal's test about the end of the first week. A positive reaction was obtained in high dilution. Later rose spots developed, but by the end of the second week, his temperature was normal. The course of the fever, the presence of rose spots, the general appearance of the patient, and the positive clumping reaction in high dilution to a dead typhoid emulsion, convinced me that this was an aborted case of Enteric fever—such a case as Dr. Powell speaks of.

CAPTAIN BIRDWOOD remarked that if typhoid fever is more prevalent among natives than has hitherto been admitted this may possibly be one reason why it continues to be so prevalent in European Cantonments. Army Sanitarians try to exclude every possible source. Attention is given to the water supply, to the disposal of night-soil, while all the time there may be a small native bazaar close by, where sanitation is not much attended to, and in which it is probable enteric not infrequently occurs. It is possible therefore that a neighbouring native population may be a continual source of typhoid infection to a European Cantonment, and this emphasizes the great importance of dealing with sanitary conditions and disposal of night soil in cities and bazaars adjoining Cantonments.

MAJOR BUCHANAN said it was more than 12 years since he began to direct his attention to the occurrence of Typhoid among natives in India. He remembered having a discussion on this subject with a senior officer of the I. M. S. who had been over 18 years in India and who strongly held that Typhoid fever did not occur among the natives of India. Since that time, he (Major Buchanan) had seen about 30 cases among natives, and in many of these cases every symptom was as clear as possible, even the spots on the skin, though the spots are not often seen. In 1895 there were several cases in the Jail Hospital and the diagnosis of Enteric was confirmed by several medical officers. The subject had been discussed again and again at the Nagpur Medical Society and the typical ulcers from fatal cases were shown on several occasions. The diazo test was applied in several cases in 1895 and it gave good results, but a case of tubercular meningitis gave a similar reaction. From the valuable contributions which had been made to the literature on this subject by Captains Lamb and Rogers, and from the fact that they have again and again diagnosed cases by the serum test, there can no longer

be any possible room for doubt that Typhoid does occur among natives of India. A number of charts were then shown to illustrate the typical gradual rise of temperature though the rise often appeared from the 3rd to the 7th day rather than in the first four days. The "level" temperature of the second week and the "zigzag" in the third week. Many cases had typical relapses. The usual mode of death was by perforation. In the early stage the absence of sweating often led to suspicion of typhoid in fever cases. Some 7 or 8 years ago Colonel Harris, I. M. S., had informed him that he had seen several cases of typhoid in natives in Calcutta many years before.

He had seen one typhus case in which there were typical spots. He had seen and made post mortems on some cases of Cerebrospinal fever, but this fever was apparently very rare. There were however about 40 cases in the Raipur Jail a couple of years ago. Influenza is a regular visitor in epidemic form now every year, and it is often very difficult to distinguish it from Malarial fever, if the blood is not examined.

He had been shown several cases of Relapsing fever in Bombay by Professor Childe in 1897, but although he had been looking out specially for such cases he had not seen any in the Central Provinces. Many people suppose that tubercle is very rare in India but it is far more common than most people are inclined to believe. During the past year, between June and December, tubercle bacilli have been found in the sputum of 23 residents in Nagpur. The specimens have been sent to the Jail Laboratory from various Hospitals and from private practitioners. It is very probable that the Malaria parasites are blamed for much sickness that is not caused by them. The tendency for Hospital Assistants to call everything of which fever is a symptom "Ague" must be well known to every Medical officer.

There are few questions more difficult, or of more practical importance, than the question—Is there an abscess? especially when it is a question as to whether an abscess has formed in the liver, or in the pelvis in a case of pelvic cellulitis. From what Dr. Rogers now says it appears that the blood count in such cases gives a good indication, and that being the case, these observations of Dr. Rogers must be of the greatest value from a practical point of view.

MAJOR GRANT said it seemed desirable that at this Conference, composed of medical officers from all parts of India, many of them men of high scientific attainments and wide experience, they should take steps to state, as clearly as possible and once for all, their views on the subject of the occurrence of enteric or typhoid

fever amongst natives of India. He would, however, preface his remarks by alluding to another disease so as to show how careful one should be before denying or doubting the existence of any particular disease in India. Sometime ago, Lieutenant-Colonel King raised the question of the occurrence of anthrax amongst human beings in India, though not for the first time, as Chevers and others had already recorded cases. But Colonel King's special point, if I remember rightly, was that it was probably a disease of frequent occurrence in certain places. Several Medical officers were asked their opinions and whilst at least one admitted the disease *might* occur, but that he had never seen a case, others (if I remember aright) denied their belief in its existence. Yet enquiry showed that it does occur, and not simply in the 'malignant pustule' form, but in the much more serious form akin to woolsorters' disease and possibly as intestinal infection. Quite recently, seeing from the Madras Board of Revenue's reports that anthrax was prevalent in a certain district, the speaker asked the District Surgeon to make enquiries and shortly received from that officer a copy of a report on a most interesting outbreak of anthrax written by a private person who wanted to know whether the strange disease thus prevalent in his village was plague or not. The report would probably be published soon in the Transactions of the Sanitary Commissioner for Madras.

With regard to the typhoid fever question, he and others had repeatedly tried to settle the matter in the affirmative, but, sooner or later, some one was sure to raise the question again as if there was still a doubt about it. A well-known Medical Officer recently stated at a Medical Meeting that "No one now questions the occurrence of typhoid fever amongst natives: the only question is as to its frequency," which latter was denied. Yet the last report of the Army Sanitary Board contains the following:—"The natives of India being exempt from typhoid fever cannot be a factor in the spread of this disease," or words to that effect! Major Grant then gave the meeting some account of his large clinical experience in this matter and stated how, like many others, he had been at first misled by the insistence of certain well-known writers on Indian diseases that typhoid fever either did not occur amongst natives of India, or at least, if it did, was essentially a different disease to that described by Murchison and others in England, &c.

Subsequently he drew up certain draft resolutions with the approval of the Members of the Conference and a most interesting discussion followed. Finally, the *resolutions, which should, as the speaker wished, settle the matter once and for all, were put before the Conference one by one, debated upon finally, and carried unanimously.

DR. ROGERS said :—

The temperature charts of typhoid in India are more often atypical than typical, quite normal charts being exceptional. There is not unfrequently a

*See page 138

tendency for the temperature to approach normal in the mornings at about the end of the second week, while the final fall by lysis is often prolonged into an intermittent fever of several days' duration. In my limited experience abortive cases ending after one or two weeks are very uncommon, although there is no doubt good evidence that they do occur, but I have not met with one in the present series of cases, and I think it is more important to lay stress on the fact that the great majority of cases in which fever remains high for three weeks or more, even in natives, are typhoid fever, while the great majority of the shorter continued fevers are malarial remittents, although further observations are required before the limitations of these rules can be laid down. Anthrax certainly occurs in Calcutta, cases of malignant pustule in which anthrax bacilli have been found having been met with in the Medical College Hospital. Tubercular disease of the lungs is also excessively common in Calcutta, being the most frequent of all causes of death found in the post-mortem room. It not infrequently follows chronic malarial fever, having been met with as a sequel to cases on which the present paper is based, and it runs a rapid course under these circumstances. Relapsing fever appears to be as rare in Calcutta as it is common in Bombay, but was met with by the speaker three years ago in the Kamaon Hills, where it was called Sunjar, which was once thought to be a mild form of plague. The best way of carrying out the leucocyte count was to prepare slides by spreading out a small drop of blood in a thin film with the flat of a needle, and stain with Romanowsky's method or the Erhlich Biondi. The great majority of the leucocytes would be found at the edges of the slides, and by working in and out down along the edge a fair count could be obtained. It was a good plan to first practise counts on normal blood until quite familiar with the different varieties and correct, that is normal counts, were obtained. The necessity of more laboratories in India, where the doubtful cases in the wards could be worked out and differentiated was a very real one, without which this country could not take its proper place in the van of progress in tropical diseases. Recently the laboratory attached to the General Hospital in Calcutta had only with difficulty been saved from an ignominious conversion into a ward for drunkards, owing to its not having been made use of for its proper purpose. It only remained for the speaker to thank the Conference for the very kind way in which they had received his paper, which would greatly encourage him in his further labours.

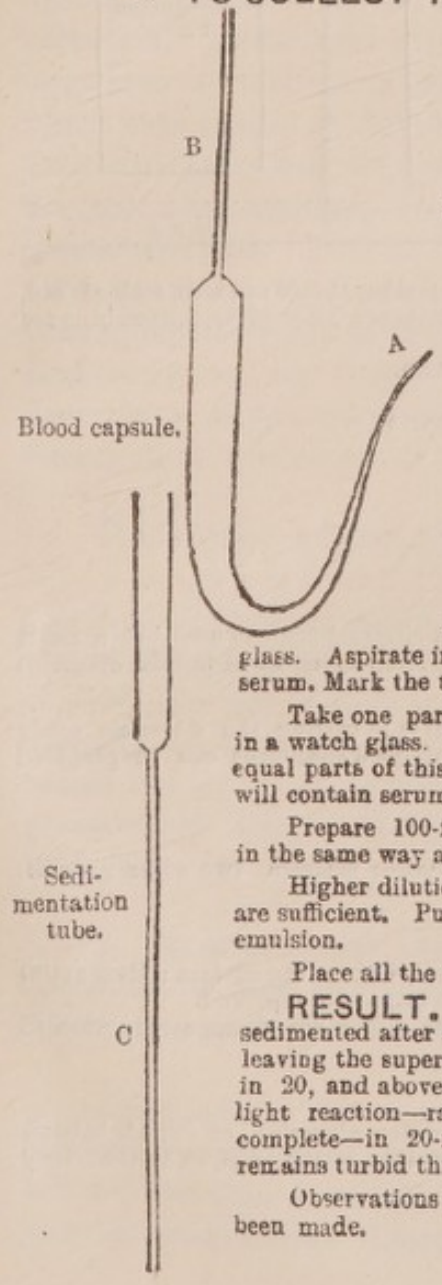
At the special request of the President, Captain Lamb demonstrated the method of carrying out the serum reaction for typhoid (Wright's method), and Major Buchanan showed a method by which tubercle bacilli can be demonstrated.

SERUM DIAGNOSIS OF TYPHOID FEVER BY SEDIMENTATION METHOD [WIDAL].

I. Articles required.—

1. Blood capsules (Wright's pattern).
2. Sedimentation Tubes (Wright's pattern).
3. Dead carbolised emulsion of *bacillus typhosus*.
4. Normal salt solution (0·75 per cent).
5. Wax pencil.
6. Watch glasses and test tubes.
7. Spirit lamp.

II. Technique.—



1. **TO COLLECT THE BLOOD.** Open both ends of the capsule. Prick the finger so as to allow of a *good* flow of blood. Fill the capsule *half full*, allowing the blood to run in through the bent limb (A). Heat slightly the whole of the straight limb (B) in the flame and seal the end of it before the limb cools. When the bent limb by this manœuvre has become empty seal it. Place the capsule upright. In an hour or two a clear serum will have exuded from the clot.

2. **TO DILUTE THE SERUM** (Prof. Wright's Procedure.) Put a mark with the wax pencil on the stem of one of the sedimentation tubes (C). Aspirate with the mouth a measure of serum up to this mark. Allow a small air bubble to come into the tube. Take in a measure of salt solution equal to the measure of serum, and then another air bubble. Repeat this until four equal measures of salt solution have been taken in. Blow out and mix in a watch glass. The mixture will then contain 1 part of serum in 5 of the total. Take one measure of this diluted serum and one measure of bacterial emulsion. Mix in a watch glass. Aspirate into a tube and seal the tube. In this preparation the serum will be diluted ten-fold. Mark the tube '1·10.'

Into another tube take 1 part of diluted serum (1 in 5), 1 part of salt solution and 2 parts of bacterial emulsion. Mix in a watch glass. Aspirate into and seal the tube. This preparation will contain 20-fold diluted serum. Mark the tube '1·20.'

Take one part of 5-fold diluted serum and 4 parts of normal salt solution. Mix in a watch glass. The serum in this mixture will be diluted 25-fold. Put up in a tube equal parts of this 25-fold diluted serum and bacterial emulsion. This preparation will contain serum 50 times diluted. Mark the tube '1·50.'

Prepare 100-fold diluted serum and bacterial emulsion from the 1 in 25 dilution in the same way as the 1 in 20 dilution was prepared from the 1 in 5 dilution.

Higher dilutions can be made if necessary, but for diagnostic purposes the above are sufficient. Put up a control consisting of equal parts of salt solution and bacterial emulsion.

Place all the tubes upright in a test tube, labelled and dated.

RESULT. A complete reaction consists in the bacteria being *completely* sedimented after agglutination, so as to form a pellet at the bottom of the column, leaving the supernatant fluid *absolutely* clear. A *complete* reaction in dilutions of 1 in 20, and above, is diagnostic of typhoid fever. Normal serum sometimes gives a light reaction—rarely complete—in 10-fold dilution, and a trace of reaction—never complete—in 20-fold dilution. This refers to dead emulsions only. The control remains turbid throughout, with perhaps a slight gravitation sediment.

Observations should be recorded from 12 to 18 hours after the preparations have been made.

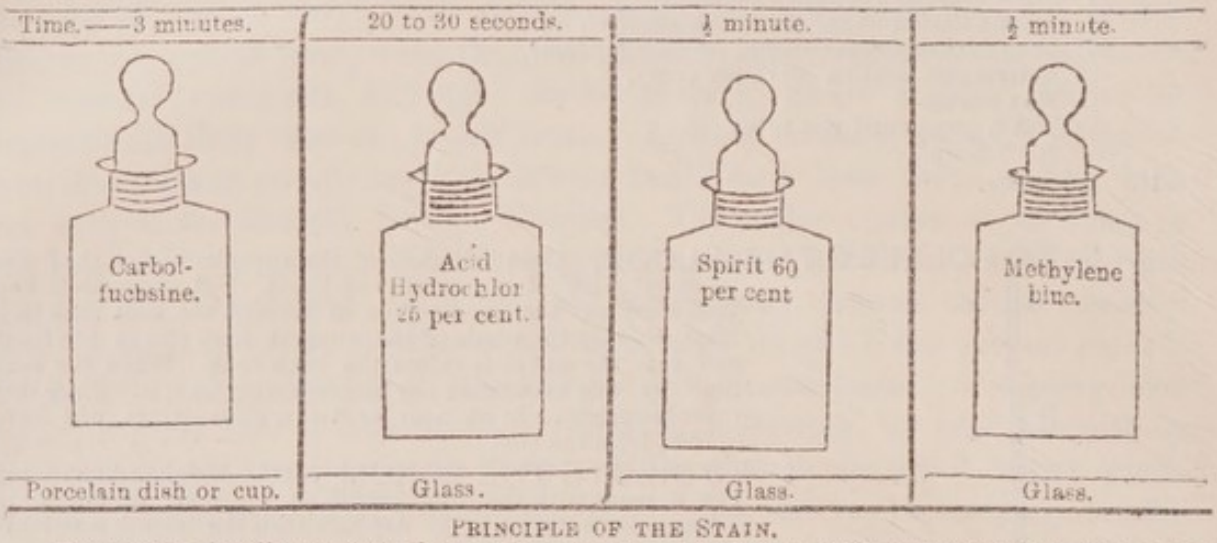
G. LAMB, Captain, I. M. S.

STAINING OF TUBERCLE BACILLI.

MAJOR BUCHANAN said that there is nothing new in the method of staining tubercle bacilli, but he thought that if the stains are arranged in a box similar to what he showed, it would be possible to train Dressers and other Hospital attendants to find tubercle bacilli.

The stain and solutions were arranged in a box, and the time during which the cover slip was to be kept in each solution was noted on the box above each solution.

In front of each bottle there was a small glass or cup into which the solutions are poured at the time of use; afterwards they can be poured back into the bottles where they remain ready for future use.

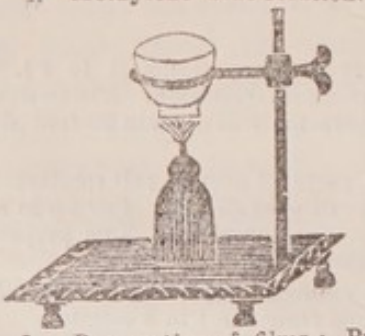


PRINCIPLE OF THE STAIN.

The tubercle bacilli are stained red with warm carbol-fuchsine; other things are also stained red, but the red is removed from these by dipping in an acid solution. These are afterwards stained blue for contrast.

STAINS AND SOLUTIONS REQUIRED.

1. Carbol-fuchsine solution.
   concentrated alcoholic solution of Ziehl's fuchsine 10 parts
   5 per cent watery solution of carbolic acid 90 „
2. Hydrochloric acid 25 per cent.
3. Alcohol 60 per cent.
4. Methylene blue solution. A very weak watery solution.



Formerly a sand bath on a charcoal fire was used, but a small cup can be heated over a spirit lamp as indicated in this diagram; this is easier and quicker.

There may be a little trouble in getting the materials ready for the first time, but afterwards good specimens can be prepared in 5 minutes.

TECHNIQUE.

1. Preparation of films: Put a small piece of tubercular matter between two cover glasses: squeeze, and slide them apart.
2. Dry in air and pass three times through the flame.
3. Float in the warm carbol-fuchsine.

The carbol-fuchsine should be heated until steam begins to come from the surface: then extinguish the flame. After about three minutes or a little longer, remove the slip, and

4. Dip in Hydrochloric acid once or twice rapidly till the colour has disappeared; wash in water. Then
5. Wash in spirit: wash in water.
6. Dip in methylene blue: wash in water.
7. Dry with filter paper or blotting paper and mount in water, glycerine, or Canada balsam.

Note:—The washing in water is done with a view to keeping the solutions clean so that they can be used again.

The bacilli appear red on a blue ground.

SECTION IV.

MOSQUITOES.

VARIATION IN SPECIES ILLUSTRATED FROM BUTTERFLIES.

BY

MR. E. H. AITKEN.

In diagnosing the species of mosquitoes and trying to settle how many there really are, I think we may get some useful hints from illustrations of the variations which may occur in a single species among Butterflies. It may help us to guard against the snare of species-making, which has done so much to discourage young collectors. Butterflies afford the best illustrations, because the wings offer such a large area for variation in colour and pattern. Not that species-making has by any means been limited to Butterflies. I once took a shell for identification to Mr. Smith of the Conchological Department of the British Museum and he showed me, one after another, three shells, under different names, with each of which it seemed identical. I asked him, "But do you think that these three are really different species"? He shrugged his shoulders, as much as to say, "*I* don't." Among lepidopterists, however, the disease has proceeded further. In Sir George Hampson's book on Indian Moths in the Fauna of British India series, the description of one common and very variable moth is preceded by a list of twenty-three synonyms, of which nineteen were given by one man!

There are several distinct kinds of variation.

1. As we all know, the size and colour of insects may be much affected by the conditions under which they passed the larva stage, especially by the quantity of food and the humidity. In a moist climate and with abundance of food, butterflies will be dark and rich in colour. Dryness and scanty fare seem to reduce the supply of colouring matter, and in desert tracts the species becomes permanently stunted and pale, just as normally blue flowers are often white in arid tracts.

2. In some species this difference becomes fixed as a "Seasonal variation," the monsoon form being so unlike that which occurs in the dry season that no one would suspect them to be the same.

There is more than one example among Indian Butterflies of a species which has been known under two names, both given by Linnæus, until quite recently, when it was discovered that the one form was produced by the other in September and *vice versâ* in June. There are usually no intermediates between these forms.

3. The first and second of these kinds of variation may be combined. For example, there is a common butterfly in Bombay, *Nepheronia gaea*, which is of a pale blue colour, with the veins and border of each wing black. It occurs all down the West Coast, but when you get as far south as Canara you find another species along with it, which has the veins and border so very much broader that there is more black than blue. This is known as *Nepheronia pingasa*, and no one looking at them in a collection would ever doubt that they were distinct species. But I found that *Nepheronia pingasa* was only to be caught during the rains and was suddenly and completely replaced by the other about October. I have little doubt now that they are seasonal forms of the same species but, if so, the monsoon form does not occur in Bombay. It has been evolved by the heavier rainfall and richer vegetation of Southern India.

4. A fourth kind of variability is called dimorphism, when a butterfly has two alternative forms strangely unlike each other. Sometimes the male has only one form, while the female has two, or even three. A very common *Papilio* (Swallow-tailed Butterfly) was described by Linnæus under three names. In this species the male is always the same and one form of the female resembles it: the other two are supposed to mimic other "protected" species.

5. In the fifth place we have to deal with individual variation, which is the most perplexing of all. In some species both colour and pattern are so variable that two specimens can scarcely be found which are exactly alike, and it is among these that the species-maker runs riot, giving a new name wherever he finds two spots which have coalesced into one, or one divided into two, or a line unusually attenuated or diffused. But if the word "species" is to have any practical value we must confine it to a community, the members of which recognise each other as being of the same kind as themselves, and interbreed. Now when we have to deal with a genus in which the species are upon the whole very similar and the individuals in each species may be very unlike, it becomes exceedingly difficult to ascertain how many distinct species there are. It is only by examining a very large number of specimens in different localities and at different seasons that one learns to estimate the value of variations and to distinguish a difference of degree from a difference of kind. I may illustrate this by *Ypthima*, a genus of the *Satyrinæ*, known in England as Wood Browns. They are small, brown butterflies, which fly near the ground and love shade. The upper side is smoky brown, but the under side is adorned with beautiful ocelli, which lie in a curved row parallel to the outer margin of the hind wing. Many species have been founded upon the number of these. But they vary indefinitely in size, some being large and beautiful, with blue-ringed centres, while others are mere black specks. Now it is evident that, when an ocellus is reduced to a mere speck, its final disappearance is only a further step, and a very short one, in the same direction; so the absence of one or more of the normal number of ocelli has no significance. But some specimens of *Ypthima*

show six ocelli, not in a row, but in three pairs arranged in *echelon*. These may confidently be put down as a different species, because the difference in the arrangement of the ocelli marks quite a distinct pattern or plan. Against this example may be set the genus *Euplœa*, which contains three species so much alike that there is little to suggest to a casual observer that they are not the same. The males can be distinguished at once by a difference in the shape of a "brand," or patch of peculiar scales on the forewing, which is a sexual character in all this genus; while in separating the females a small white spot in the cell of the forewing is quite sufficient for the identification of one of the species, because in this genus the colour is not subject to variation. The discovery of the larvæ of these three species has shown that they might almost be put into different genera,—so important are the differences in their early stages.

This case illustrates the importance of knowing an insect in all its stages and not only in the last. Much misclassification of butterflies would have been avoided if their metamorphoses had been more studied. It is also important to know the insect as a living thing and not only as a specimen. The food, habits and habitual attitudes will often point to differences which are deeper than those indicated by colour, and a true naturalist sometimes finds it easier to distinguish two species on the wing than on a pin. I will close with an example of this. The Indian butterflies of the order *Hesperiidæ* (known in England as "skippers") may be roughly divided into two groups, of which one comprises those which rest with their wings folded behind their backs, and the other those which spread their wings out and may easily be mistaken for moths. Of course this difference is not recognized in museums. Many years ago I sent the late Mr. deNiaville two species to name for me, which he returned labelled as *Plesioneura ambareesa* and *alysos*. I remarked "*alysos* has no business to be a Plesioneura, for it folds its wings behind its back," and shortly after that he himself published a paper proposing a new generic name for *alysos* and some other similar species. More recently, the discovery of a large number of the larvæ of these butterflies in Canara has shown that, while those which fold their wings behind their backs feed exclusively on Monocotyledons (grasses, palms, arums, &c.) the others feed on plants belonging to several different orders, but all Dicotyledons, which seems to indicate some very deep-seated difference between these two groups.

RELATION BETWEEN 'SPECIES' OF ANOPHELES AND THE ENDEMICITY OF MALARIA."*

ABSTRACT OF PAPER BY DRS. STEPHENS AND CHRISTOPHERS.

The authors drew attention to the fact that in the native quarter of Calcutta they had found anopheles in myriads, but that there was no infection of the children.

* NOTE.—Paper in full in Reports to the Malaria Committee of the Royal Society Series VI, Harrison and Son, St, Martin's Lane, London.

They also failed to find any infected anopheles among a large number examined. In Calcutta the only common species of anopheles was A. Rossii.

A very low endemic index was found to exist over the greater portion of Bengal they had visited, and in these districts only three species of anopheles appeared to be common—namely, A. Rossii, A. Fuliginosus, and A. Nigerrimus.

In the Bengal Duars child infection was however very marked, the percentage being as high as that encountered in Africa. Here, for the first time, they encountered a small species of anopheles (A. Christophersi) resembling A. Funestus of Africa. This was the commonest anopheles in the Duars. In this species they readily found sporozoits.

In the Punjab they found also a considerable amount of child malaria. Two species of anopheles were common in the bazaars in Lahore, *viz.* A. Rossii and a species (A. Culicifacies) also related to A. Funestus.

In order to compare the carrying power of the two species (A. Rossii and A. Culicifacies) specimens of both were caught at the same time in the same houses. In every house examined sporozoits were found in A. Culicifacies, but never in A. Rossii. In a dissection of nearly 500 specimens of A. Rossii no sporozoits were found, whilst in 200 A. Culicifacies, eleven with sporozoits in the glands were encountered. In the bazaar, A. Rossii did not appear to be carrying malaria while A. Culicifacies was doing so.

The authors thought that a likely explanation of the absence of malaria in Calcutta was that A. Rossii, which is the only common species, did not in nature always carry malaria. They thought a difference in the power of the different species of anopheles to carry malaria would be a very simple explanation of the puzzling variations of endemicity which evidently do not depend upon the mere number of anopheles present.

They noted the fact that in the Duars the quartan parasite was much the commonest form, whereas in Lahore the quartan was never once found by them, the simple tertian parasite here being much the commonest. They thought that the different species of anopheles might have some relation to this distribution of the parasites.

Feeding experiments however have shewn that A. Culicifacies, A. Metabolis, A. Fuliginosus, A. Theobaldi, A. Rossii, and A. Turkhudi all allow zygotes of malignant tertian to develop in the stomach wall.

Further work was therefore needed before the relation of species to endemicity could be determined.

CAPTAIN LEONARD ROGERS remarked that he had recognised that the want of correspondence between the maximum prevalence of anopheles and malarial fevers in Calcutta might depend on Anopheles Rossii not being an efficient carrier of malaria, and that the varieties called A and B by Giles were to be found in the roadside drains during the fever season. He had arranged 16 months ago to test experimentally whether each of these kinds could carry malaria or not, but the China war had had the effect of preventing his carrying out his intention by causing his transference to another post. Such exigencies of service conditions were not sufficiently allowed for by those who criticised the amount of scientific work done in India, and it was for this reason that the uninterrupted and long continued work of commissions, such as the present malaria one, were of so great value in India. The question raised in this paper was a most important one practically, and would require much patient work for its elucidation. If it could be shown that Anopheles Rossii did not carry malarial infection the problem of lessening malaria in Bengal would be much simplified.

CAPTAIN LISTON said he had already drawn attention to two instances which would support Drs. Stephens's and Christophers's statement that certain species of anopheles appear to carry fever more frequently than certain other species of anopheles. He lived in a house in Ellichpur from September to December 1900 in which he was able to catch many species of anopheles. Particularly abundant were A. Culicifacies and A. Listoni. In this house all his servants were, at least once during these months, attacked by fever. In another house in Bombay, during the same months September to December 1901, he was able to catch large numbers of anopheles, but they all belonged to one species, *viz.* A. Rossii. Although the number of anopheles were as abundant in the Bombay house as in the Ellichpur house and their opportunities to become infected in neighbouring native huts, just as great in each place, yet no person in the Bombay house was attacked by fever during these common fever months.

He had received lately from Captain Hagel Wright of Aurangabad some specimens of anopheles mosquitoes caught in his house, in which almost all the inmates had been ill with fever. An examination of these specimens showed that by far the largest number of anopheles were A. Culicifacies and A. Listoni.

MR. POWELL was not prepared to acquit Anopheles Rossii of the charge of conveying malaria.

In the Bombay Police Hospital, it was almost usual for patients admitted for small wounds, gonorrhœa, tubercle, and other non-malarial disease, to contract malaria about a fortnight after admission. These were patients whose medical history was known and who had been free from malaria. It was not unreasonable to assume they were infected in the hospital where there were never less than a score of malaria cases.

The place swarmed with A. Rossii, and Mr. Powell had never found any other species of anopheles in the neighbourhood.

Anopheles Rossii was found by Mr. Powell in the overflow from stinking cess pools. It was generally assumed that they only lived in clean running water.

The members had all seen Dr. Christophers demonstrate zygotes of malignant tertian in the stomach of A. Rossii.

A BASIS FOR THE CLASSIFICATION OF INDIAN ANOPHELES,

BY

CAPTAIN LISTON, I. M. S.

Since Ross in 1897 first discovered that the human malaria parasite could be cultivated in mosquitoes of the genus Anopheles, much work has been done by many observers to indicate that a study of the different species of anopheles is necessary to completely understand the epidemiology of this disease.

Variation in habits.

Much has been written on the habits of Anopheles as a genus. A study of this literature points to the fact that the habits of Anopheles in one part of a country are different from their habits in another part of the country. This variation in habits is best explained by the fact that in the one place a certain species of anopheles is the most common while in the other place quite another species is the common anopheles. In this respect contrast the habits of anopheles in Bombay and Calcutta with their habits in the Deccan. We find that in these sea coast towns Anopheles Rossii is the common Anopheles while in the Deccan Anopheles Culicifacies is perhaps the Anopheles most frequently met with in the dry season.

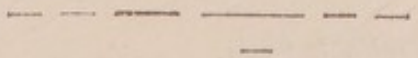
The study of species important.

Yet again, if any crusade against mosquitoes (with a view to Malaria prophylaxis) is to be successful, we must understand thoroughly the habits of the various species of Anopheles in their adult and larva forms. The study of their habits is greatly simplified by a preliminary study of the various species. Thus, for example, one who has been in the habit of looking for larvæ in Bombay will almost always find pools which contain the larvæ of Anopheles Rossii; he will not think of looking in the places where he could find Anopheles Culicifacies larvæ; he has in fact studied the common Anopheles of Bombay and has neglected the haunts of the less common A. Culicifacies which breeds in streamlets. Moreover it has recently been shown that in certain places where there are many Anopheles, fever is rare, and on the contrary in

other places where there are comparatively few Anopheles, fever is common.* Such facts are probably best brought in correlation with the Mosquito Malaria theory by the explanation that in one instance many Anopheles of a species which does not readily act as a carrier of malaria were found while in the other case some suitable malaria carrying species of Anopheles was present. To record a specific instance—in one house in which I lived from August to December the common mosquito was Anopheles Rossii. Only one specimen of any other species was taken in this house although some hundreds of Anopheles must have been captured. All of us in the house, including the servants, remained entirely free from fever. In another house, during the same months August to December, in which many species of Anopheles were found but, in particular, large numbers of Anopheles Culicifacies and Listoni, all my servants without exception were once or twice attacked with fever. Another case may be interesting in this connection. I received some specimens of mosquitoes from Captain Wright of Aurangabad. In his letter he told me that the specimens had been caught in his house in which almost every inmate had been attacked by malaria. An examination of the specimens showed that by far the larger majority belonged to the species A. Culicifacies and A. Listoni. It thus becomes important to study the species of Anopheles.

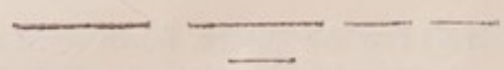
Basis for classification.

In attempting to differentiate the various species of Anopheles, it is necessary to find some basis on which to classify them. At first, in accordance with the method of classification of butterflies, attention was directed to the wings. Now when a large number of Anopheles are examined, it can be shown that the wing in apparently the same species varies considerably. These variations consist essentially in an increase or a decrease in the length of the black scaled areas. Let us examine, for instance, two hundred Anopheles Rossii, we will find such variations in the wing costa as the following. I may mention that Captain James first wrote to me, saying that Dr. Stephens had found variations in the wings of A. Rossii, and asked me to examine a series of A. Rossii in detail. The most common markings on the wing costa of A. Rossii are six dark scaled areas separated by five light scaled areas,

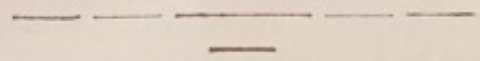


Three of the dark markings are large and are situated in the middle of the costa. There are two small basal dark dots and one special small dark scaled area. Beneath the middle of the large central dark scaled area there is a small dark scaled dot on the first longitudinal. From this normal the following variations occur.

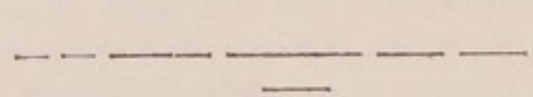
* Compare Reports of Malaria Commission, September 1901.

(1) 

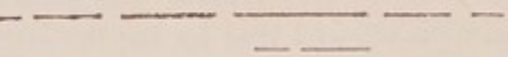
The two small basal dots may be wanting.

(2) 

The inner of the three median large black areas may be united to the middle large black area and so form one large black area.

(3) 

The dot below the median black dot on the costa may be placed below the outer end of the large black costal dot.

(4) 

There may be two black dots below this median black area.

And so on with other variations on the wing veins. Not only can variation be found on the wing pattern in different specimens of the same species but variations are to be found on each wing of a single specimen. Again, if a classification of the species is based on the wing only such very different species as A. Listoni and Turkhudi would have to be classified near one another, for these wings are almost indistinguishable from one another.

Markings on legs.

The markings on the legs again although not so variable as the markings on the wing still show considerable variation, both in different specimens of the same species and in each side in the same specimen. These differences and variations are particularly apparent in specimens of Group V noted below. It would be necessary too to class near one another, if the markings on the legs were taken as a basis of classification, such very different mosquitoes as A. Nigerrimus and A. Rossii.

Palpi markings—the most reliable basis.

Finally an examination of the palpi of the female Anopheles would appear to afford the most reliable basis for classification. In a large number of specimens of any species of Anopheles the markings on the female palpi are almost if not quite invariable. This statement does not apply to male Anopheles.

A glance at the classification of Indian Anopheles on such a basis shows that the Anopheles arrange themselves into well marked groups. I am indebted to Captain James for the help he has given me in drawing up the table of Classification.

Classification of Indian Anopheles.

Drawn up by Capt. W. Glen Liston, I. M. S., and Capt. S. P. James, I. M. S.

Hill Species

A Palpi unbanded.—

Group I.
- A. Lindesayii (Giles)
- A. Gigas (Giles)

Wild Species

Group II. A. Barbirostris (Wulp)

B Palpi with four white bands.—

Group III. A. Nigerrimus (Giles)

Group IV. A. Pulcherrimus (Malaria Commission)
- A. Sinensis
- A. Annularis
- A. Indiensis
- A. Pseudopictus

} Sub-species (Theobald.)

Domestic Species.

C Palpi with three light bands.—

A. Tips of Palpi white.

Group V. Tips of hind legs white.
- A. Fuliginosus (Giles)
- A. Pallidus (Theobald) } Palpi with terminal white band broad. Two basal bands narrow.
- A. Jamesii (Theobald)
- A. Theobaldi (Giles) } Palpi with two distal white bands broad Basal band narrow
- A. Maculata (Theobald)

Group VI. Legs black Tarsi unbanded.
- A. Fluviatilis (Malaria Commission) [*Synonym A. Christophersi (Theobald)*] } Third longitudinal vein mostly white scaled.
- A. Listonii (Giles)
- A. Indicus (Theobald)
- A. Culicifacies (Giles) } Third longitudinal vein mostly black scaled.

Group VII. Tarsi banded.
- A. Rossii (Giles) } Palpi with terminal white band broad. Basal two bands narrow
- A. Stephensi (James and Liston) } Palpi with two distal white bands broad. Basal white band narrow.

[*Synonym A. Metabolis (Theobald)*]

B. Tips of Palpi black.

Group VIII. A. Turkhudi (Liston)

Group I are the hill species; Groups II to IV are wild species; Groups V to VIII are the domestic species. Groups I to IV are characterized by the possession of large scales on the wings. Groups V to VII have relatively small scales on the wings. We are thus able to see that, as far as the adult Anopheles are concerned, this basis of classification divides them into well marked and closely related groups.

My own studies only lead me to this point, for on my transfer from Ellichpur to Bombay all opportunity of working at larvæ was practically gone, but since coming here Drs. Stephens and Christophers of the Malaria Commission, who have made a special study of the larvæ and eggs of Anopheles, have been kind enough to show me the points of difference in the various larvæ of the different species of Anopheles. Their work is extremely interesting and instructive, and curiously bears out this classification of the Anopheles on the basis of the banding on the palpi.

I have been able since coming here with the great opportunities afforded us by Major Buchanan to confirm most of Drs. Christophers's and Stephens's work on the eggs and larvæ.

Thus, for example, the larvæ of Groups II to V live in deep still water where there is plenty of green weed. The larvæ of Group IV love flowing streamlets. The larvæ of Groups VII and VIII love puddles and pots and care less for clear sweet water than other Anopheles larvæ. Little is known of the habits of the larvæ of Group I. Dr. Christophers has pointed out that the larvæ of Groups I to V are characterized by the possession of branched frontal hairs and "cockades" while Groups VI to VIII have simple unbranched hairs on the front of the head.

Anopheles Turkhudi which is relegated to Group VIII differs from all the other Anopheles in that the tips of the palpi are black. Dr. Christophers has noticed that it differs from other anopheles larvæ in assuming to some extent the attitude characteristic of Culex larvæ when resting at the surface of the water. Moreover the egg of A. Turkhudi much resembles a Culex egg. For details of his work I must refer you to the Reports of the Royal Society.

Number of species.

You will see from the table that I have noted some 20 different species of Indian Anopheles. The names I give have for the most part been derived from Colonel Giles's new edition of the Culicidae. Although I have taken care to enumerate these 20 species I would not have you think that I believe there are so many species. I am inclined to take Mr. Aitken's advice and guard against the snare of species-making. I think there are not more than twelve species of Indian Anopheles. I have numbered consecutively the twelve common species. The specimens of Group V vary very considerably. I should like very much to study further the larvæ and eggs of this group and in particular any seasonal variation that

may occur in the species of this group. Such an end can only be obtained, as Mr. Aitken has pointed out, by carefully noting on each specimen the date and place of capture of each. I cannot do better than conclude this paper by repeating Mr. Aitken's words: "It is only by examining a very large number of specimens in different localities and at different seasons that one learns to estimate the value of variations and to distinguish a difference of degree from a difference of kind."

Dr. Christophers remarked on the recent great increase in the known species of Indian Anopheles. A year ago four species only were described whilst now there are certainly fifteen or more.

The only sufficiently accurate description of these as yet has been Captain Liston's descriptions and drawings of many of the species. The classification by the palpi noted by Captain Glen Liston divides the known species into very natural groups similar to those based upon a study of the ova, larvæ habits and appearance of the adult insects as described by the Malaria Commission. The classification of Indian Anopheles into natural groups is of wide interest since it is probable that various countries will be found to have representatives of these. It is evident that the African species A. Funestus belongs to the stream-loving family to which A. Culicifacies and A. Listoni belong. The African species A. Paludis appears to be related to the group of wild mosquitoes in its habits and appearance.

Major Buchanan said he had been trying for some time to distinguish one anopheles from another by the wing markings. Subsequently Captain Liston very kindly sent to him the Classification which had been made by him and Captain James, and with the result that what seemed to be a hopelessly difficult subject was at once transformed into a very simple one. By following the classification which is based on the markings of the palpi and of the legs, anyone could learn how to distinguish one anopheles from another in a very short time. No one who had not spent hours or days trying to distinguish the different kinds of anopheles by the wing markings could appreciate at its proper value this most useful classification.

THE COLLECTION AND MOUNTING OF ADULT MOSQUITOES.

BY

Captain S. P. James, I. M. S.

The collection of adult anopheles mosquitoes in most parts of India is a very simple matter, provided search for them is made in the right places. We know that the majority of the known species sleep during the day-time in houses and

sheds, and in such places they may be easily captured. In order to catch them, a few dry test tubes and a large dry bottle with a narrow neck (such as an empty whisky bottle) are necessary. The mosquitoes can be caught while they sit asleep on the roof or walls of the room by very gently placing the open mouth of the test tube over them, and when they have flown into the tube carefully insinuating a plug of cotton-wool between the mouth of the tube and the wall or roof against which the tube is pressed. The mosquito is then transferred to the large bottle by placing the mouth of the tube over the mouth of the bottle and carefully withdrawing the cotton wool plug. The mosquito will fly into the large bottle, and the test tube can be used again.

In this way, if the anopheles are at all plentiful, fifty or sixty can be caught in a very short time.

Before, however, commencing to search for adult anopheles, one should select carefully a suitable place of search. A native village or bazaar with breeding places near (such as a stream or canal or ponds) should be chosen in preference to any other place. In such a village there will probably be several old unoccupied houses and huts, and it is in these we are most likely to make a good catch of anopheles mosquitoes. It is almost useless to search in a new house with whitened walls.

The best place of all is an old unoccupied house with smoke-blackened thatched roof and mud walls in the middle of the village. It is better to look first in an unoccupied house, because the smoke from the wood fires in houses where people are living drives most of the mosquitoes out into the nearest empty house or shed, where they rest during the daytime, to return again when all is quiet at night.

Next to such a house as has just been described, a cowshed in the middle of the village is the best place in which to look for anopheles. The roofs of cowsheds are generally low and easily accessible, so the anopheles are easily seen.

Native carpenter's shops, wood-sheds, and the barracks of native soldiers, if old and not recently whitewashed, are also good places to search in.

Having selected the house in which to commence the search, if the roof is too high to be easily examined, we should mount on a box or ladder, so that our eyes are about a foot off the ceiling. Then each section of the thatch should be carefully examined, especially the darker corners and the angles between the rafters and the thatch. The commoner species, such as Anopheles Rossii, are usually seen at once, because they are light-colored and large and stand out against the black back ground of soot like little white thorns hanging from the roof; but the small anopheles are difficult to see. This is especially the case with anopheles Culicifacies which hides most successfully in holes and corners of the roof. It is very liable too to be mistaken for a culex as it does not assume the characteristic attitude which other anopheles do, and looks very like a small brown culex. For this reason, in rooms which are

badly lighted, it is best to catch all the mosquitoes one can see without taking note at the time whether they are culex or anopheles. As each mosquito is caught, the tube containing it can be taken to the light and examined, and only the anopheles transferred to the large bottle. In occupied houses, and in barracks and hospitals, we are more likely to find anopheles on dark-colored clothes hanging in the corners of the rooms, and experiments have shewn that they choose to alight for preference on dark-blue cloth rather than cloth of any other colour. Saddles and harness hanging up in rooms are also favorite places for anopheles to alight upon, and in the saddle rooms of British cavalry regiments they are usually very plentiful.

There are certain species of anopheles which are rarely found in houses and these may sometimes be caught in the open by the following method, which I understand was first used by Drs. Stephens and Christophers in Africa. On a quiet night, when there is no wind, a white sheet is hung between two poles or on a line near the ground, preferably under trees, and a lighted lamp is placed near. The mosquitoes and other flies are attracted by the lamp and alight on the white sheet, when they may be caught by placing a test tube over them in the usual way.

Another plan that often yields good results, is to erect a tent in the open and to allow a native to sleep in it for a night or two. In the mornings many anopheles will be found in the corners of the tent and beneath the folds of its hangings.

The mounting of Anopheles.

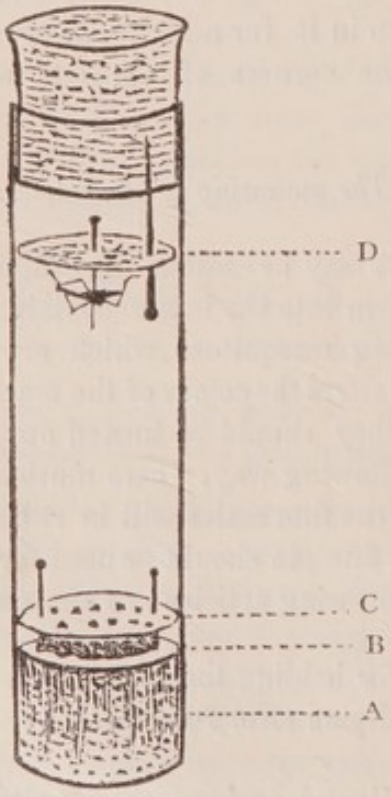
The insects when caught may be killed by dropping a small piece of cotton wool saturated with chloroform into the bottle containing them. Tobacco smoke should not be used for killing mosquitoes which are required for purposes of identification of species, as it alters the colour of the markings on the wings and legs. When the insects are dead, they should be turned out on to a clean white sheet of paper and mounted in the following way: care must be taken not to touch them with the fingers, or some of the fine scales will be rubbed off, and if it is necessary to move any of the insects a fine pin should be used for the purpose. In order to mount the mosquitoes the following articles are necessary :—

(1) A pair of forceps for holding the pins.
(2) Fine entomological pins (No. 20 size).
(3) Common pins.
(4) Small discs of cardboard such as those used for gun wads (size of a 20-bore gun).
(5) A wooden box (such as a cigar box), in the bottom of which is fixed a layer of cork-carpet, or pith.

A card disc should be taken, and all the data concerning the specimen to be pinned should be written upon it. Then placing the disc on the table, one of the fine entomological pins held in the forceps should be thrust through it until about half its length projects through the centre of the disc. The mosquito is then laid *on its back* (turning it over with the aid of a pin or needle) and the pin which carries the disc is thrust through the centre of the thorax, between the points of origin of the legs, until the point of the pin projects somewhat beyond the dorsal surface of the thorax. The disc is now inverted (the mosquito will then be right side up) and an ordinary pin is thrust through the disc near the margin, for the purpose of attaching it to the cork in the bottom of the entomological box. The wings and legs may now be carefully arranged with a fine pin, but if they can be seen moderately well it is best not to touch them, as even the most careful manipulation will rub off a few scales and hairs.

In India, mosquitoes very quickly become covered with moulds, and in order to prevent this, and to preserve them properly, mosquitoes are best kept in small glass tubes—such as the one shown in the figure.

Mosquito tube (Natural size.)



A. Cork fixed in tube
B. Muslin bag containing napthalene.
C. Perforated disc to keep B in position.
D. Card-disc carrying the mosquito.

A flat cork (A) fitting the tube tightly is first pressed into the tube to its end. On this cork a small muslin bag containing napthalene or camphor is placed (B). This is kept in position by means of a cardboard disc (C) perforated with holes which is fastened by pins to the cork at the bottom of the tube. The disc carrying the mosquito (D) is pinned to another cork which is inserted into the mouth of the tube.

By this method mosquitoes may be preserved in good condition for a long time, and if the tubes are packed firmly in a tin box with cotton wool, they may be sent through the post with great safety. Nothing is more disappointing than to be told—after one has taken the trouble to collect and send mosquitoes for identification (possibly to England),—that "the specimens are too rubbed for identification" or "the specimens are covered with moulds;" but if the above directions are carried out, such disappointments will not occur.

HOW TO COLLECT AND IDENTIFY ANOPHELES

BY

CAPTAIN LISTON, I. M. S.

CAPTAIN JAMES has shown you how to catch and pin a mosquito. You will now have to find out to what group of species it belongs.

In order to be able to do this, you must know something of the anatomy of a mosquito. Like other insects, it has a head, thorax, and abdomen. Protruding from the centre of the head in front is the proboscis. On either side of this and of equal length to it in the genus Anopheles are the palpi. Behind and above the palpi are the antennæ. The head is joined to the thorax by the neck. From the thorax arise the wings and legs. The abdomen is divided into segments, and the last of these segments is modified in the male to form the "forceps," and in the female to form the "ovipositor." It is important to know something further about the wings. On the wing are veins which have a definite arrangement. Each vein has received a name. These names are: (1) the costal vein ; (2) the first longitudinal vein ; (3) the second longitudinal vein with anterior and posterior branch; (4) the third longitudinal vein; (5) the fourth; and (6) the fifth longitudinal veins each with anterior and posterior branches ; (7) the sixth longitudinal vein. Along the inner edge of the wing is "the fringe."

In addition to these veins, there are certain small transverse veins, joining the longitudinal veins with one another. The most important and largest of these veins is the subcostal or auxillary vein which joins the costa to the 1st longitudinal vein.

The different segments of the legs have received names, *viz* :—(1) the coxa, (2) the trochanter, (3) the femur, (4) the tibia, and (5) the tarsal segments.

In order that we may be able to identify the mosquito, we first turn to the palpi and note if there are, or are not, bands of light scales on them; we also note the number and relative size to one another of the bands, and if the tip of the palpi is black or white. Having noted these points, you will be able to place the mosquito in certain classes shown in the table I have given you. Your attention should next be directed to the hind legs. You note if the tip of the hind legs is white; if not white—are the joints between the tarsal segments banded or not? By this means you will be able to identify to which group any species of Indian Anopheles belongs.

MOSQUITO EGGS AND LARVÆ.

BY

DR. J. W. W. STEPHENS.

DR. STEPHENS said that the importance of species was considerable. The different species of anopheles, for instance, were markedly selective in their breeding places.

A. Nigerrimus would never be found in a pool such as those described by Ross. Nor would A. Rossii be found in the large sheets of water frequented by A. Nigerrimus.

In Mian Meer the larvæ of A. Stephensi were never detected except in paraffin tins or water pots and from this source no other larvæ but those of A. Stephensi were obtained. In Nagpur A. Stephensi was found to be fond of small pools by the side of the streams such as those made by the feet of cattle. A. Culicifacies and A. Christophersi were most distinctly stream breeders occurring in mountain streams, nullahs and irrigation canals. Anopheles Rossii was very distinctly a foveal mosquito whilst some species, especially A. Nigerrimus, were found in the most remote jungle.

A. Lindesayi was very distinctly a hill species and was found near Darjeeling-Missouri at a height of above 6,000 feet. This species has never been found in the plains.

The question of how far anopheles bred in swamps, rice fields, &c, was largely a question of species.

DR. CHRISTOPHERS gave a demonstration on the recent work of the Malaria Commission on the specific differences in the eggs and larvæ of anopheles. This was of special importance in classification but was also a convenience in research.

The ova and drawings of ova of the different Indian species were shewn. Several types of ova were found. The ova of A. Culicifacies (Giles), A. Christophersi (Theobald), and A. Nigerrimus (Giles) closely resembled one another and differed from the other Indian species, in an extraordinary narrowing of the upper surface and the separation of the floats from the rim. It was a marked characteristic of the larvæ of these species that they were found in open waters.

The majority of the anopheles had ova with broad upper surfaces and floats touching the rim. They however varied very much in detail. The ova of A. Rossii (Giles), A. Stephensi (Liston), A. Fuliginosus (Giles), and A. Pulcherrimus (Theobald) were briefly described.

The ovum of A. Turkhudi (Liston) was different from other anopheles ova in many points. It does not possess floats or an upper surface with a rim or fringe but resembles very much a culex ovum. On close examination a curious oval structure is to be seen at one end representing the upper surface and fringe of other anopheles ova. When placed on water the ova of A. Turkhudi sank. In captivity the ova were laid in a heap on a floating piece of paper.

The larvæ of the different species were also briefly described and specific differences noted. The differences found to be of specific importance were certain hairs on the head—the antennæ and the palmate hairs. Also to some extent the pattern on the dorsal surface of the head. The larvæ of A. Nigerrimus and A. Barbirostris were seen to be markedly different in many points from other species.

The larva of A. Turkhudi was also seen to be a very aberrant form—having palmate hairs only on 2 or 3 segments and lying at a slight angle with the surface of the water.

DISTINGUISHING MARKS OF ANOPHELES LARVÆ AS SEEN BY THE NAKED EYE.

BY

MAJOR A. BUCHANAN, I. M. S.

MAJOR BUCHANAN gave a short Demonstration of the various kinds of Anopheles larvæ that are found in Nagpur. He had been trying for some time to see if it were possible to distinguish the different larvæ by any naked eye appearances, and though the subject had not been worked out fully, he thought a few remarks on

this point might be made now. Although it is difficult to describe the distinctive marks, still the men who are daily sorting out the larvæ are able fairly well to divide them into the separate groups.

(1) The Culicifacies is the most common. The larvæ are small, and they have two white or yellowish rings—one on the 5th segment, and one round the neck. The men who are sorting them call these 'double rings.'

(2) Fuliginosus is also fairly common. It can generally be distinguished by a silver streak running down the back as far as the 5th segment—'silver backs.'

(3) Jamesii—very like the Fuliginosus.

(4) Stephensi is also common. They have a light-brown body and a dark head (cobra-heads).

(5) Rossii has also a light-brown body and a dark head. Rather like Stephensi.

(6) Listonii is small and has large hairs on the thorax and upper segments. There is no very distinct naked eye appearance, except perhaps long black line down the back.

(7) The Barbirostris can generally be distinguished by its size, but in colour it varies much; sometimes being dark-brown, sometimes light-brown, sometimes having a bright silver streak along the back, and sometimes a number of silver specks on the back. They very often lie in a bent position and this is their chief characteristic.

(8) Turkhudi: light-brown colour with a black speck on the back. Put a number in a tumbler, and contrast with Culicifacies. The Culicifacies are like well-drilled soldiers and parade around the side of the glass in a wonderfully regular line; the Turkhudi never get into a regular line, but float irregularly in the middle of the surface. They hang their heads down, but not as low as a Culex. These are the only anopheles that hang with their heads a little distance below the surface. The Turkhudi has only a few palmate hairs, and this is an interesting fact when considered in connexion with its curious behaviour in a glass of water.

(9) Nigerrimus: A large larva—looks thin, with big head.

(10) Theobaldi: Silver back with white ring behind the thorax.

He had to acknowledge the valuable assistance he had received from Dr. Christophers and Captains Liston and James.

ON THE FEEDING AND DISSECTING OF MOSQUITOES.

BY

DR. S. R. CHRISTOPHERS.

BEST results obtained in large wide-mouth bottles. A large wide-mouthed jar has a piece of paper or card board or a few stalks of straw pushed into it. The whole is kept inverted over a watch glass of water in which a piece of cork or paper is allowed to float. The mosquitoes do not readily fly downwards so the jar may be moved without much danger of any insects escaping. To feed—the bottle is placed on a piece of mosquito netting. The netting is then tied round the neck and the bottle placed under the moistened forearm of the subject on which the mosquitoes are to be fed. No other food is provided in the case of anopheles but blood, on which they are given the choice of feeding every night. A very convenient bottle to use is the large chatney jar with a hollow stopper—the inverted stopper forming an excellent vessel to contain water which is most essential.

Dissection.

The best method of dissecting the stomach is that described originally by Major Ross. The mosquitoes are allowed to remain a day or if necessary three days without feeding in order that the stomach may be emptied of all blood.

The thorax is transfixed by a needle and the insect placed on its back in a drop of saline. The last two or three abdominal segments are then loosened by making a slight nick with a needle on either side. The separated segments are then carefully drawn away from the rest of the mosquito.

The white and transparent viscera are seen stretching between the two. The stomach is the last of the viscera to be drawn out. If the stomach appears to be about to remain attached to the body of the mosquito instead of coming away freely, it is necessary to cut into the thorax with one of the needles a process which divides the alimentary canal above the stomach.

A small board half covered with black paper and half with white will be found very useful. Surgical needles with cutting edges will also be found very useful in mosquito dissection.

The structures seen in the dissection of the stomach are generally (1) the two ovaries with more or less developed eggs; (2) the five glistening white Malpighian tubes lying along with the intestine (hind gut); (3) occasionally also the nerve cord with its ganglia is pulled out but this is unusual.

The needle should be used to cut across just below the stomach and to remove all the viscera together with the last few segments thus separated, leaving the elongated fusiform body—the stomach, on the slide. All loose eggs and fragments of legs are removed from the slide, the excess of saline wiped off and the stomach covered with a cover glass. It ought to then flatten out considerably and look transparent.

Certain normal structures may at first be mistaken for parasites, namely—

(1) a loose half developed ovum.

(2) a single cell of the fat body—a large very distinct structure with many vacuoles.

(3) a pericardial cell—large cells lying alongside the heart.

These are very large bodies containing brownish pigment. They may be pulled out with the stomach.

(4) Epithelial cells of the stomach which are swollen up. These often shew curious boiling movement of granules.

The real zygote may be distinguished in its early stage by its clearness and by the presence of distinct malarial pigment.

Dissection of the glands.

The glands lie in the front portion of the thorax near the sternal surface. To dissect them a needle is thrust into the thorax first behind the origin of the neck. An endeavour is then made to detach the head, neck and breast of the mosquito in one piece. The head is then turned lower surface upwards and held in this position by one needle while the other is used to carefully loosen and detach the various fragments of chitin which are present. After most of these are detached a small piece of tissue ought to be still present attached to the neck. This is then carefully severed from the head, and covered with a cover glass. The whole six glands are displayed if the dissection has been successful.

The spermatheca.

It is convenient to examine the spermatheca in some cases to demonstrate fertilisation or the reverse of the mosquito. The last two segments of the abdomen are removed and teased up. A small black body will be seen to be loose in the issues this is probably the spermatheca. A low power at once detects the curious

ball-like structure with its duct. The spermatheca is carefully separated from surrounding fragments and crushed under the coverglass. If fertilisation has taken place spermatozoa are seen freely moving about, or lying motionless in the field. Demonstrated also the development of the ovum. The formation of the yelk and the absorption of the nurse cells.

The structure of the proboscis especially the salivary groove and duct in the hypopharynx and the formation of the sucking tube by the approximation of two separate bodies the labrum and hypopharynx. Also the mechanism of the large pumping organ in the head of the mosquito.

SECTION V.

PRACTICAL MEASURES.

Abstract of Captain Birdwood's paper on SOME PRACTICAL SUGGESTIONS FOR THE PREVENTION OF MALARIAL FEVERS.

Captain Birdwood referred to the advance which had been made in regard to our knowledge of the cause of malaria and said that although there are many interesting problems still to be solved, the time seems to have come when the practical Sanitarian can step in and use the newly-acquired knowledge.

Much has already been written about malaria prophylaxis and the value of the different methods, but beyond the disinfection of tanks in Calcutta, he believed very little has been done practically in India. The subject may conveniently be divided under two headings—(1) domestic prophylactic measures, such as can be carried out on a small scale by the doctor and his patient, in and about the patient's home—as the use of mosquito curtains, the isolation of the sick, and the treatment of breeding pools in the compound; (2) State prophylactic measures—such measures as can be carried out by Municipal or Cantonment authorities. He did not in this paper propose to deal with the former at all, or even to go in full detail into the latter, but rather to point out a few of the common insanitary conditions met with in municipalities and cantonments, which predispose to malaria, and to discuss a few suggestions as to how best we might deal with them.

Study of local conditions.

In dealing with malaria prophylaxis in India there are two important factors which one should always bear in mind. These are the facts that the most prevalent conditions in one place may scarcely be found in another, and that a species of anopheles which is common in one place may be rare in another. Although the fundamental principles of prophylaxis, (*i. e.* the suppression of the anopheles and the protection from their bite) are the same at all stations, yet a hard and fast set of rules for every locality cannot be laid down. For instance, conditions predisposing to malaria in a comparatively dry place like Nagpur are

very different from those met with in the dense jungle of the Terai; and the conditions which obtain in a dusty cantonment of the Punjab are very different from those of a water-logged municipality near Calcutta. In fact each town has its own peculiarity : in one an excess of tanks, in another bad non-masonry drains, in another excessive canal irrigation, and in another bad hydrants. Therefore, if we wish to get the full measure of success of our prophylactic preparations, it seemed to him most important that local conditions should be first well and carefully studied. A hard and fast set of rules circulated to magistrates and subordinate medical officers without reference to local conditions, will be productive of comparatively little good, except for general guidance. If each medical officer in India will carefully study the local conditions of his town or station in the light of the researches of recent years, he will find many conditions which can be remedied, and he will be able to suggest a practical line of action to his local authorities.

Crusade against obvious anopheles ponds.

First he would like to preach a crusade against *obvious anopheles ponds* in cantonments and municipalities. Although local conditions vary much throughout India, yet there are several conditions predisposing to malaria, which are common to all municipalities. One of these is the presence of very obvious anopheles ponds. These ponds are often so conspicuous, and so close to houses and inhabited spots, that if householders and medical officers realized the danger they are, immediate steps would be taken to have them filled in. The prevalence of these ponds varied very much in different stations. In one or two cantonments he had found them almost at every corner. He gave in detail a few of the causes of these ponds, what sort of localities they are found in, and how to deal with them :—(1) A very frequent position is the corner of a European compound. Such ponds are usually caused by the coolies of the landlord, who come to repair the stables or the servants' houses, and for this purpose, excavate earth. Full of algae and stocked with anopheles larvæ, they are a dangerous source of fever to the European inmates of the houses, and also to the native servants and syces who live close by. (2) Other obvious anopheles ponds are frequently met with near native regimental lines. The houses of the Sepoys are generally built with mud bricks, and the earth

for the annual repairs is taken from a pond in the immediate vicinity of the lines. (3) Other offenders in this respect are brick and tile makers. In order to get earth for their bricks, large ponds are formed within municipal limits near inhabited areas. There is one municipality in the N. W. P. notorious for its high fever death rate, and this he attributed chiefly to the presence of numerous old brickfields where ponds abound. (4)Anopheles ponds too, are often made by men, who contract to repair the roads. In order to bank up the metalled surface, earth is dug from a ditch at the roadside. This procedure does not matter when it is done out in the district, away from towns and villages, but when numerous ditches are made along the road side within cantonment and municipal limits, numerous anopheles pools are formed, which become a danger to the community. (5) In two municipalities he had found the railway authorities to be the creators of a large set of anopheles pools. When new railway lines are being carried through a town, earth on each side of the line is excavated for embankments and thus numerous ponds are formed.

One of the questions of practical prophylaxis is—how best to deal with these obvious anopheles ponds. Some could not be filled up without considerable expense, but in very great many cases—such as those found in compounds—the ponds are not very large, and could be filled in with little trouble. The fact is that neither the householder, nor magistrate, and—in some cases—not even the doctor, realizes their dangerous nature. They see a pond ; but their eyes are blind to its significance and influence. If every medical man in India would keep his eyes open for obvious anopheles ponds, and preach an earnest crusade against these, much good might be done. The eyes of authority and those of the public generally only need to be opened to their danger, and action will be taken ; for, if Cantonment authorities know of a source of fever, they are only too willing to deal with it. If the tenant knows that the pond at his gates is the source of fever to himself and his household, he will do all he can to get it filled up. Much may be done at small expense, if each medical officer will use his local influence, and do what he can to get these ponds filled up.

He thought, however,that Government might help much in dealing more effectually with these ponds and preventing their formation in the

future, and he suggested the following lines of action:—

(1) Cantonment authorities might be asked to send a special Health officer round every cantonment, to make a list of these ponds with a view to have them filled in.

(2) Byelaws might be made prohibiting the excavation of earth within cantonment, or municipal, limits.

(3) Brick and tile-making might be classified as dangerous trades, and not permitted within municipal limits.

(4) Road-repairers might be prohibited from digging ditches at the side of roads near inhabited sites.

(5) Railway authorities should be prohibited when carrying a new line through a town, from excavating earth for embankments, within municipal limits. Earth can easily be obtained from outside.

Importance of Masonry Surface Drains.

After the removal of obvious anopheles ponds, he thought the Health officer or Civil Surgeon could not too strongly insist upon the importance of *masonry surface-drains* throughout his municipality. In his opinion it was the keystone of the whole question of the reduction of malaria in municipalities. He took this view chiefly on consideration of three facts in the life history of the anopheles larvæ, which we would, he was sure, pardon him for mentioning—(1) anopheles larvæ seldom develop on the side of a masonry drain; (2) a larva takes 10* days to develop into an imago; (3) few larvæ develop in swiftly flowing water. They all knew that the anopheles larva loves the grassy banks of "non-masonry" ponds and ditches, so that our first fact shows how important surface drainage is. Even garden irrigation—if in masonry channels—can be carried on close to the house without any danger. In municipalities and cantonments bad surface drains, and stagnant ditches at roadsides, are the most frequent breeding places of anopheles mosquitoes. If the roadsides are badly drained, and if these drains are carelessly cleaned without consideration of gradients, and if the public works are allowed to dig ditches at the side of the roads, there would be innumerable centres for the spread of fever. The large increase of fever in the rains is chiefly due to the accumulation of water in bad surface drains.

* About 14 days from egg to imago.— Ed.

PONDS NEAR WELLS OR HYDRANTS.

In addition to bad roadside drains he would like to mention a few other places, where surface drainage is often very bad in municipalities and where a great outlay would not be necessary to remedy it. For instance, frequently the drainage round the mouths of wells and round hydrants is very bad. Fresh waste water is added daily, and accumulates in a ditch or morass near the well, and forms excellent anopheles breeding-places. A municipality introduces water works and puts up hydrants in every quarter of the town; but makes no provision whatever for taking off the waste water, so that round every hydrant good anopheles pools are found, and several hundred centres for the spread of malaria are established throughout the town. In fact in more that one town the fever death-rate has considerably risen since the introduction of a pure pipe-water supply, and this has been attributed to the pools of fresh cool waste water which accumulate round every hydrant. As an instance of the great value of good masonry surface-drainage, he cited the town of Shajahanpur in the North-West Provinces (where there is now a Boer Camp.) This town has not only good masonry drains in its roads and streets, but also very large ones outside the town, the consequence is that this town is one of the healthiest, and freest from malaria in India. As an instance of the bad effect of non-masonry surface-drains, he cited Loralai in Beluchistan, where irrigation is carried on in every garden and along every road, in natural surface channels; the consequence is that this place is one of the most feverish cantonments in India. To get masonry surface drains in a cantonment or municipality, you will say is merely a matter of money. Well, so it is to a certain extent, but not altogether. For instance, money has occasionally been available in municipalities, and no one has thought of devoting it to surface drainage. So the first thing is to get Health Officers and Magistrates to realize that to ensure thorough surface drainage is almost the most important principle of municipal sanitation. Secondly—if much money be not available—a good deal may be done on a small scale—*e. g.* improvements round wells and hydrants; or one small area might be taken in hand each year. For badly waterlogged municipal areas, no doubt, an expensive and well planned drainage scheme is the only remedy; but in other towns, if we get one or two good masonry drains made each year, they will, in the end, do much.

Most municipalities have a small yearly allotment for sanitary improvements, and Health officers would do well to give surface drainage first consideration in distributing the money. Lastly, he thought it cannot be too strongly insisted on, that no municipality should institute water works, without at the same time submitting plans and estimates for efficient surface-drainage from hydrants. Without such a provision, no scheme ought to be passed. If Sanitary Engineers and Health officers, who give the support of their opinion to these schemes, will strongly insist on this, much ill health will in the future be avoided.

Dangers of Canal irrigation.

There is, he thought, no doubt that canal irrigation is a great source of fever to a locality, and he advocated the importance of lining with masonry, the sides of all canals and irrigation-channels within cantonment limits. Cantonments such as Mian Mir, Peshawar and Quetta are all very feverish spots, and are all well supplied with irrigation systems. The fever is very largely due to the fact that anopheles larvæ develop at the sides of the smaller irrigation channels. It is of course impossible to do without irrigation; but he thought that the fever of these cantonments would be greatly reduced, if all canals and small irrigation-channels within their limits, were lined with masonry sides or walls. This would of course be a matter of considerable expense; but the money would be well laid out, considering that the cost of a European Soldier to the State is popularly estimated at over £ 100, and also the fact that in these cantonments, at certain seasons of the year, the mortality from malaria is very high. Vast sums are yearly spent on such military works as barracks, in comparison with which the expense of making masonry walls to all canals in a cantonment would be small. We might, he thought, urge this reform on the ground of the permanent healthiness which it would bring to a station. Private residents too, if they wish to indulge in the luxury of a garden, should be compelled to make all irrigation-channels in their compounds of masonry. He thought the Conference might suggest to Government the advisability of trying, as an experiment, the introduction of masonry sides to all canals and smaller irrigation-channels within the limits of one cantonment—such as Peshawar or Mian Mir.

A DETAILED SEARCH FOR POOLS AND A MALARIA MAP.

There are occasions when anopheles ponds are not quite obvious. A set of buildings, or even a whole town, may be severely affected with malaria, and yet very few pools and ponds are visible. Under these circumstances he thought a good deal of good could be done, if municipalities were to obtain the services of an officer with a special knowledge of malaria, to make a systematic and detailed examination of the local conditions, and to make a rough map in which he could show—with dots of red ink—the principal breeding places of anopheles in the town. Dr. Neild Cook, in his last Calcutta report, states that a serious fever epidemic, which occurred in some workmen's sheds, was very successfully checked by treating some neighbouring anopheles pools, for which careful search was made. Local authorities—if they had a good knowledge of the chief anopheles breeding pools, and if the locality of these was carefully noted on a map—would be in a position to cope with the original source of the disease, and could probably very effectually deal with it. A Civil Surgeon has not time to make this detailed search himself, and at present Health Officers (in many cases natives) have not the requisite training. Such an expert examination of a locality appears to be all the more necessary, when we consider the many varying conditions which affect the breeding places of larvæ. For instance: *Anopheles Rossii* prefers pools like buffalo pools, while *A. Jamesii* probably prefers clearer water. Again, *A. Nigerrimus* and *A. Barbirostris* are most frequently found in big tanks. Other factors also come into play, such as the slope of the bank and the nature of the grasses. For instance, anopheles larvæ will seldom be found in pools with high rank grass, so that one hollow with water in it may be harmless, and another a good breeding place. In fact, as Captain Glen Liston told us yesterday, different species are to be found in different places. If, once for all, the chief breeding-places of anopheles are marked down, the Cvil Surgeons and local authorities could successfully deal with them, and thus whole blocks of buildings might be rendered much more healthy. He thought the Conference might suggest to Government that in towns and cantonments, which are especially malarious, the visit of a special officer, who could map out the sources of the disease, would be followed by practical results.

Mosquito Brigades.

In connection with the filling up of pools and the clearing up of insanitary conditions, Ross has strongly recommended the employment of gangs of coolies or "Mosquito Brigades" who shall make a thorough and systematic cleansing of the town, and thus at one swoop, greatly reduce malaria. The measure is reported to have met with considerable success in Sierra Leone, and it would probably do much good in an Indian city : but on the whole, it was, in his opinion, not very suitable to Indian cities. Many of the conditions around—such as bad surface-drainage—are too big to be touched by a band of coolies. Again, many of the insanitary conditions, which have to be dealt with, are in the yards and compounds of native houses, and there is nothing the native of this country resents more than interference in and around his house. The measure, then, is one which should be adopted with much caution. It seemed to him that much more good will be done by quietly and persistently filling up ponds and ditches, quietly and systematically improving the surface drainage, and gradually educating the natives to realize the dangers of insanitary conditions around them. This however is a matter of opinion, though no doubt this measure could be applied with considerable success over small areas of a town, especially where a Medical officer is well known and trusted, and the people may be induced to give their consent and willing assistance.

The influence of overcrowding.

There is one insanitary condition on which he should like to lay stress, and that is the overcrowding among native servants attached to European households, and he wished to advocate the importance of paying some attention to this matter. There is no doubt that the more crowded a native quarter is, the larger the number of fever cases there will be. Indeed among all grades of Indian life, the poorer and more ill-housed the people are, the larger will be the number of enlarged spleens among them. This shows that overcrowding and insanitary conditions have a great influence on malaria in Indian cities. The Calcutta municipality has made a move in the right direction during the last year in opening up crowded areas and commencing the erection of model lodging houses for native workmen in the city. But this sort of reform requires very large expenditure, and much philanthropy and private generosity. He thought, however, something might be

done for the overcrowding of native servants in cantonments. The ordinary staff of servants attached to a European household is a big one, but when two or three officers share one house—what with three sets of syces* and "grass-cuts"—the overcrowding becomes acute. Often whole families occupy only one hut. Servants are constantly suffering from fever, and mosquitoes love their dark ill-ventilated houses, and there is nothing to prevent the anopheles (which generally breed in a pond in a corner of the compound) from carrying fever to every inmate of the household. He thought a bye-law to prevent overcrowding among servants in cantonments would do much good. Servants' houses are not expensive to put up, and the landlord could be compelled to build as many as are necessary. The Cantonment magistrate could keep a list of the number of servants' houses, and the number of servants allowed in each compound; and if a return was obtained from each tenant every month of every person living in his compound, a check could easily be kept. All native servants who enter the houses of, and attend on, Europeans should live under exceptionally good sanitary conditions. If in England it is held to be necessary to legislate for the cubic air-space on board a canal boat, surely it is worth our while to do something for our native servants, and he thought a bye-law in all cantonments on this subject would do some good.

GAUZE WINDOWS AND DOORS FOR BARRACKS.

Another measure he should like to advocate for cantonments is the provision of gauze doors and windows for the barracks of European troops. About the great value of mosquito-curtains as a prophylactic measure there is no question. It is the most valuable means of prevention we have. Investigators can go with impunity into the most malarial jungles of Africa, if they have mosquito-curtains; whereas without them, it is almost certain death. It is obviously quite impossible that the native population should provide themselves with mosquito curtains, but this advantage might well be extended to the European Soldier. As he said before, the cost to the State of the European soldier is by no means a small item, and the provision of gauze doors and windows in his barracks would not entail a very heavy expenditure. The anopholes, it is stated, seldom bite men except

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* Grooms.

when asleep, so that the European soldier, sleeping under an electric punka, and protected by gauze windows and doors, would stand a very good chance of escaping infection. This is such a practical method that it seems to him well worthy of trial, and he begged to suggest to the Conference that Government might be asked to supply, as an experiment, gauze doors and windows to the barracks of one or two stations in India—such as Rawalpindi or Peshawar—in order to test their prophylactic value.

Fumigation.

Another prophylactic measure which he believed has not yet been tried in India, is the fumigation of rooms and houses. This he wished to advocate on account of some recent experiments by Dr. Rosenau, Director of the State Hygienic Laboratory at Washington. The *State Bulletin* No. 6 of September 1901, published by the Government Press, details his experiments. He has found that sulphur dioxide, although it is, as we know, a weak bactericidal agent (especially when dry) yet is a powerful insecticide even when much diluted by the air. Dr. Rosenau, among other experiments, burnt 6 ozs. of sulphur in a room of 500 cubic feet capacity and in one hour all the mosquitoes were dead, although their cage was wrapped round with four layers of towelling. The application of this prophylactic measure is of course very limited, for unless you destroy the anopheles pools the insects will continue to prevail. But if you can find the pools and destroy them, sulphur fumigation will prove a very valuable adjunct, for the fully-developed insect, as you know, may continue to live for many days in dark overcrowded native houses, even after his breeding places have been destroyed. This measure might be especially valuable in dealing with coolie sheds in Assam, with workmen's quarters in Calcutta, or with native regimental lines. It is especially suitable to India, for not only do the natives view it with approval, but it is easily applicable to their small ill-ventilated rooms. He thought it was well worthy of a more extended trial. There is no doubt too, that if a private house be badly infected with mosquitoes, it could be rendered fairly mosquito-free if those who live in it were to turn out all their goods, and thoroughly disinfect the rooms with sulphur; but this is a method of domestic prophylaxis with which he was at not at present dealing.

PROPHYLAXIS BY QUININE.

Quininising the community has, as we know, been strongly advocated by Koch as the most powerful prophylactic measure we have. But the practical impossibility of quininising the densely crowded cities of India is obvious. He thought, however, that the general use of quinine could be much more pushed than it is at present.

(1) For instance : at many dispensaries a patient has to attend daily for one dose of quinine, perhaps walking a mile or two. If he were at a London Hospital, he would get a bottle of medicine to take away with him, to last several days. But the Indian patient has to come daily for his quinine—in order that his presence may augment the daily attendance. He thought that it would enhance the prophylactic influence of quinine, if medical surbordinates were allowed, or even ordered, to give a bottle of quinine mixture to poor patients to take away with them if they want it.

(2) Secondly, every branch dispensary ought to have a very full supply of quinine at the beginning of the rains. If a return, showing the exact amount of quinine in stock, were sent from every dispensary on June 1st, it would enable the authorities to see whether sufficient quinine was being supplied. Celli and nearly all authorities now agree that the giving of small doses of quinine is of no avail either as a curative or prophylactic measure. And there is no doubt that, if the supply of quinine to a dispensary be a small one, the medical subordinate uses it with a sparing hand.

(3) Again, the amount of money spent on quinine in a civil district always seemed to him to be very small, considering the general malarious nature of the country. It would be interesting and instructive to know the exact amount which each municipality spends per annum on quinine for its charitable dispensary. If the amount spent seems small, the municipality might be encouraged to increase it.

EDUCATION.

Although education is scarcely a prophylactic measure, yet there is no doubt that without its assistance we shall do very little. Minor sanitary defects, as pools of water which up till now have scarcely been

noticed, will in the future be considered the worst of sanitary evils. The more public opinion is educated on malaria and its causes, and the more people learn to associate malaria with mosquitoes and pools of water, the more active and thorough will be our prophylactic measures. Private persons are generally very willing to remedy defects which threaten the safety of their homes, if they are only shown what to do. And Municipal Boards are always ready to receive advice on sanitary measures, and to act on this, if they have the money. In Madras, circulars on the prevention of malaria have already been issued to all Municipal councils; but he had not had an opportunity to see one. He heard that similar circulars are to be sent to every municipality in India. This diffusion of knowledge is the best aid we can have, and these circulars, backed up by a knowledge of local conditions, will be sure to bring about many useful sanitary improvements. A general knowledge of preventive measures might, he thought, be pushed still further, and he had prepared three leaflets containing instructions for the prevention of malaria, which are appended to this paper as appendices A. B. and C., copies of which have been distributed to all present.

A. contains instructions for Private persons.

B. for Municipal Boards.

C. for Cantonment authorities.

He had made these instructions as short and as simple in lauguage as possible, omitting all details about the life-history of the mosquito, so as to render them suitable for people without scientific knowledge of the subject. He begged to submit these leaflets to the Conference for consideration and such amendments and additions, as officers can make; and also to suggest that a sub-committee be formed to prepare a final form of these leaflets, which they might submit to Government as a standard set of rules for guidance.

(2.) The education of the more advanced scholars in native schools on the subject of malaria, is also a measure well worthy of encouragement, and would in the future bear good fruit. Something more than a leaflet would be necessary, and a chapter containing all the essential facts in the life-history of the mosquito, and principles of prophylactic

measures, might well be added to the small sanitary primer, which is in use in Indian schools. He begged to suggest to the Conference that Government be asked to introduce such a course of elementary instruction in native schools.

(3.) Again, he saw no reason why every medical subordinate should not be able to make blood films and prepare specimens, to identify the different varieties of parasites, and also to catch and identify the anopheles larvæ. Major Buchanan has shown the Conference that the necessary technique and knowledge can well be grasped by an intelligent native. It would very materially help Civil Surgeons and Health officers, if their subordinates could search out anopheles pools near infected houses or barracks, and if they could save them the necessary prolonged labour of searching through several blood specimens. He begged to suggest to the Conference that Government might be asked to start special classes for this instruction at all medical schools in India, so that the subordinates of the future may have a thorough education in this respect.

LEGISLATION.

Lastly, he would like to say a word about legislation in connection with malaria prophylaxis, or how Government may best help us in the fight. No doubt each medical officer can do much by his own influence and advice; but there are certain measures which cannot be carried out without the help of Government. He had mentioned some of these in the course of this paper. He had also collected several of these recommendations on sheet D, which he submitted to the Conference for amendments and additions, and for some final recommendations to Government, and he begged to suggest that a sub-committee be formed to consider this also.

CONCLUSION.

In conclusion, he could only say that malaria prophylaxis is a very big subject—too large in fact, and with too many aspects, to be treated in a single paper. He felt that he had only touched very inadequately on one or two points; but he had tried to deal especially with those, in regard to which we can do something really practical. After all it was, in his opinion, very largely a matter of sanitation. The lower in the

social scale we go, the worse are the insanitary conditions we meet, the more prevalent is the malaria, and the more virulent is its type. If we improve the ventilation of native houses, the less anopheles will we find in them. If we relieve the overcrowding in the houses of our native cities, the fewer victims will the mosquito find. If we improve the surface drainage of towns, the fewer opportunities for the development of mosquito will there be. The essential principles lie in sanitation, backed up by some special knowledge of the mosquito, and a few exceptional precautions. Nuttall has shown that anopheles mosquitoes are by no means extinct in England, and it is more than probable that the fact that malaria has become extinct in England, is very largely due to the improved sanitary conditions of our towns and villages, and the better housing of the poorer classes. And it is because the sanitary surroundings of the people, who live in Indian towns and villages, is still so far from perfect, that the death rate from malaria is still so high.

The impossibility of quininising the whole community, the presence of rice fields, and the abundance of anopheles pools are facts which need not daunt us. Much has already been done by Italian sanitarians, and Ross reports that he has met with considerable success in Sierra Leone. If any one doubts the utility or ultimate value of our efforts, we can already point to these results. It is time that we in India too tried something definite. It is needful, he thought, not only that all medical men should be in earnest about malaria prevention, but that they should persuade all local authorities and residents to be in earnest too. We should convince them that they have no longer to deal with a theory at which they can scoff, but with definite factors in the causation of a disease, which saps the strength and lessens the wealth of our Indian Empire.

APPENDIX A.—Instructions for the prevention of malaria for private persons.

" B.—For Municipal Boards.

" C.—For Cantonment Authorities.

" D.—Some suggestions as to how Government might help.

[As these Appendices are very much the same as those passed by the Sub-Committee (see page 131) they are not printed here.—ED.]

CAPTAIN LEONARD ROGERS remarked that it was very satisfactory to find in this debate such a general agreement on the main principles of action against malaria, that there should be no difficulty in drawing up a plan of campaign by a committee based on the lines suggested in Captain Birdwood's paper. This would no doubt be circulated by Local Governments for the guidance of municipalities and others. His experience of sanitary work in Bengal, however, led him to fear that all action might end there, and little practical good would result. He would therefore suggest that this Conference should also recommend that all Local Governments, &c., should further carry out test experiments, under different conditions, in favourable and limited areas, under special officers, with sufficient funds, by which means definite and self-evident results would be obtained, which would serve both as an object lesson and a stimulus to all local bodies to do everything that was possible to obtain similar good results. *

DOSAGE OF QUININE.

Another very important point was the dosage of quinine. The present two-pie packets contained only 5 grains. This should be increased to 10 grains as a minimum, and similar doses should be used as a prophylactic. He had found from the experience of two controlled trials that doses of 5 grains and under had practically no prophylactic effect, and the use of such small doses was only a waste of a precious drug. If such doses had no preventive effect, what curative action could be expected from them? Yet in Assam he had been told by a district medical officer that *kala-azar* could not be malarial because quinine had no effect on it, and on inquiry found that the drug was given in two or three grain doses, one day's medicine only being supplied to patients coming several miles with fever! No wonder quinine thus administered falls into disrepute. It might as well have been thrown away. Larger doses will prove economical by cures being effected with very many fewer doses, but a more liberal supply should be furnished to all dispensaries in malarious districts.

SEGREGATION.

Lastly, he wished to refer to the question of segregation, which had been so ably advocated by Drs. Stephens and Christophers in their West African reports. In addition to the segregation of Europeans as far as possible from natives there was another condition in which this measure might be of the utmost value, and that is in checking the spread of epidemic malarial fevers such as that now happily on the wane in Assam. As early as 1897, some two years before Ross established the mosquito theory, the speaker recognised that this epidemic form of malaria was slowly and indirectly infectious, and acting on this discovery carried out successfully segregation measures. Having also observed that the infection was in abeyance

* See Resolutions, page 140.

during the coldest months of the year (due as we now know to a low temperature preventing the maturing of the zygotes in the anopheles) he had all those who had no *kala-azar* in their households moved out of a cooly line in which more than half the families were infected, to a new one over a mile away during the cold weather with the result that among them and over 300 newly imported coolies living with them no cases of the epidemic malaria had occurred within the next four years of which he had received information. Yet of 60 healthy coolies, who lived close to the infected line, and were not moved, one-third died of the disease within one year. Further, in three less severely infected lines containing over 1,000 coolies he had all the infected families only moved out, with the result that, instead of having 73 deaths from this fever as in the previous year, only six cases had occurred a year later, although a much higher mortality than in the previous year might have been expected from previous experience. The principle of segregation, adopted as a result of a conviction of the infectiousness of this outbreak of malaria, was in these cases eminently successful.

Captain Lamb said :—

I should like to offer a word of explanation as to the reason I rise to make any remarks on a subject of which I have no experience and before a meeting of expert malariologists such as this. I feel however that it may help the sub-committee in drawing up their report to hear how the question strikes a laboratory man looking at it in a common-sense way. There are three points then which strike me forcibly.

Firstly, it seems to me that in drawing up any scheme of malaria prophylaxis, it is absolutely necessary to keep separate, those measures which are applicable for the European population, either individually, or collectively, and those measures which would be necessary for native villages, towns, and municipalities. I should think that the prophylactic measures for soldiers in barracks, and for European communities in cantonments generally, would be simple and easy and of slight expense compared to the measures which would have to be adopted in the case of villages and towns. Therefore let us keep our recommendations quite distinct in this particular.

Secondly, it is absolutely necessary that in every place in which it is proposed to adopt prophylactic measures the local conditions be carefully studied beforehand by a competent expert. From what I have heard and seen, it is evident to me that the measures which would be applicable to one place would not be suitable for another. If this is not done—and done efficiently—and if a general cut and dry scheme be ordered for each place irrespective of the local conditions, then I say that no good results will be obtained and people will certainly begin to doubt that mosquitoes have anything to do with malaria.

Thirdly, I think that on studying the local conditions one will be met with the difficulty that the prophylactic measures which suggest themselves at once as the proper and ideal measures will not be feasible on the ground of expense or for some other reason: while this is so, one will probably see that other measures, not so radical, not so certain of success perhaps, can be carried out. These we might call the temporary measures. Let it then be clearly understood that temporary measures may be recommended and adopted in those localities in which it is impossible to carry out the more radical and permanent improvements.

I should say, then, that these three points should be carefully kept in view in drawing out any recommendations which are to be submitted for the consideration of Government.

CAPTAIN LISTON said there is one point which he thought was not brought out sufficiently clearly in paper D. There are certain places in all Cantonments in which even at the present time all the sick, including those who are suffering from malaria, are collected, for example—Civil, Regimental and Jail Hospitals. These are great sources of infection. He suggested that they should be made as far as possible mosquito proof.

In the *Indian Medical Gazette* of December 1900 and October and December 1901 he had drawn attention to the distribution of anopheles larvæ in the Ellichpur Cantonment. The places in which he found the larvæ in that Cantonment are much the same as those described by Captain Birdwood. He would only like to draw particular attention to the great source of anopheles in many Cantonments in the river which flows near or through it. This source he considers to be of the greatest danger to Cantonments, particularly in the light of Drs. Stephens's and Christophers's work which points to the fact that such a place is the most suitable breeding place for A. Listoni, which they have shown to be probably the most important carriers of Malarial infection.

CAPTAIN SUTHERLAND suggested that instead of the 10-grain doses which Captain Birdwood recommended, the method which Koch recommended might be tried, *viz.* 1 gramme (15) grains of quinine once a week. He had made some experiments in Saugor Jail and found that this plan was not only effectual, but there was less expenditure of quinine.

CAPTAIN HEARD suggested that Government be not asked to issue instructions regarding preventive measures in Municipalities until very thorough experiments have been made in selected Cantonments (say one in each Province) where both British lines and Native Bazaars can be dealt with together. Pending the results

of such experiments which he thought must extend over a somewhat prolonged period—say 2 or 3 years—to avoid any errors that might result from abnormal rainfall, &c., every endeavour should be made to educate the public—both European and Native—in matters relating to Malaria. Plans of drainage should be worked out by competent Engineers in conjunction with the officers of each Municipality, and these should be carried out as funds become available—and in order that this might be done he suggested that the District Board Engineer should be under the supervision of the D. P. W. and be obliged to work with this object in view.

Major Hendley said that whilst endorsing the extreme desirability of insisting on the elementary Hygienic principles advocated by Captain Birdwood, he deprecated the idea that his suggestions are in any way novel, or a consequence of our present knowledge of Malaria causation. They had, as Sanitary District Officers, advocated from their youth up empirically the very sanitary improvements which Captain Birdwood now suggested as novelties. His idea was that our present knowledge of the etiology of Malaria will not result in any appreciable diminution of the disease.

Major Buchanan said:—It is important to recognise that measures which may suit well in one locality, or in one class of the community, may not be equally suitable in other districts, or among people whose condition of living is different. It would be well, then, to have before us, when considering what measures are most suitable, a list of the methods which have been recommended, and for this purpose the following Classification of measures has been prepared:—

(1) Kill the parasites in the body: by quinine or methylene blue.
(2) Isolation: (*a*) by camping far from infected villages.
(*b*) by reducing the number of servants in the compound.
(3) Kill mosquitoes:
(*a*) by smoke. (*b*) by noxious gases as Sulphur dioxide. (*c*) by catching them.
(4) Keep mosquitoes off:
(*a*) by mosquito curtains. (*b*) by mosquito proof rooms. (*c*) by the application of certain oils to the skin. (*d*) by tobacco smoke.
(5) Kill the mosquito larvæ:
(*a*) by putting oil on pools
(*b*) by Mosquito Brigades (Ross)
(6) Reduce the number of breeding places:
(*a*) by drainage
(*b*) by substituting masonry channels for earthen channels
(*c*) by filling up holes
(*d*) by preventing excavation of earth.

Having considered all the methods which have been recommended they would then be in a position to work out a scheme that would suit the conditions of each place and each class of people.

(1) It would not in most places be possible to kill the parasites in all the native population, but the more free distribution of quinine to servants would help to reduce the chance of infection among Europeans.

(2) When camping, if it is known that a particular village has a large infection, it would be well to keep as far away from that village as possible.

(3) The killing by smoke or noxious gases would only be resorted to in very exceptional circumstances, but if servants are trained to catch the mosquitoes that get inside the mosquito curtains and inside our houses, the number of mosquitoes can be very much reduced. It is an easy matter to teach any man how to catch mosquitoes with a glass test tube and a bottle with a paper valve on the top into which the mosquitoes can be put, one by one, as they are caught.

(4) The mosquitoes can be kept off by mosquito curtains fairly well, but although this is the most satisfactory method in the cold weather it is not a comfortable plan in the hot weather. In the hot weather, however, the punkah is a very good substitute as the mosquitoes will not come under a good punkah if it is well pulled. The application of oils to the skin may be useful especially in the case of children. Oil of cloves is probably the best preventive, and it has the advantage of not having an unpleasant smell.

(5) Where there are a number of isolated breeding pools, oil may be poured on the water, but in small streams—and it is these small streams that anopheles breed most profusely—the application of oil would be impracticable, for in the first place a very large quantity would be required, and in the second place the water of such streams is often used for drinking purposes. In such places the Mosquito Brigades as recommended by Ross would be most useful.

(6) The measures described above are all of a more or less temporary nature. He then referred to the measures which would be of more permanent benefit. And the first of these is drainage—both superficial and sub-soil. There are few places where this could not be carried out, and in the smaller streams a V shaped channel is the best, as, if the gradients are properly attended to, there will always be sufficient flow to carry away the mosquitoes' eggs.

Then where irrigation is carried on, the substitution of built drains for earthen drains, or to use the expressive vernacular terms the substitution of "pukka" drains for "kutcha" drains, would be a useful plan, especially in the neighbourhood of Cantonments.

The filling up of holes in the ground and the prevention of excavations would also be good measures. But in spite of all attempts in this direction there would still remain a number of breeding places. For instance, during the past rainy season he had observed a small hole in a palm tree, which had been cut for the extraction of toddy, and in this he had seen throughout the rains a considerable number of larvæ. The particular tree was on the Golf course and he had an opportunity of seeing it very often during the rains. As all such trees are tapped regularly there must be a large number of similar breeding places in a palm-growing district. Nevertheless, the great point is that the greater the diminution of anopheles the less will be the chance of infection,

Perhaps the most important point in prevention will be the necessity of teaching the Natives the fact that the Malarial fevers are due to parasites, and second that the parasites spend one stage of their existence in the anopheles. Natives are a very practical people, and they will never enter heartily into any scheme for prevention until they have grasped the idea that the parasites are carried by mosquitoes. Having once been convinced of the fact, there is no doubt that a large number will take steps to prevent themselves and their families from being bitten. With a view to spreading the knowledge of the fact that the anopheles are the culprits, two methods might be followed :—first, all Medical subordinates should be taught how the infection is carried, because at the present time the majority of them do not believe in the mosquito-malarial theory, and as a large number of the population accept their opinions on medical subjects, it can hardly be expected that the general population will be convinced while the Medical subordinates remain doubtful; second, the life cycle of the mosquito and the cycles of the parasites in the human blood and in the mosquito could be taught in schools. Without some such plan the probability is in favor of the Natives taking only a very half-hearted action in the matter in the present century.

In conclusion he had to thank Captain Birdwood for his excellent paper. Fortunately, owing to a telegraphic error, Captain Birdwood had arrived in Nagpur a few days before the Conference began. The few extra days were however well spent for he was able to write the very excellent paper which they had just heard. He thought that Captain Birdwood had dealt very fully and very thoroughly with the State prophylactic measures and that his paper was one which will be of the greatest value.

Major Roberts, I. M. S., Indore, gave a short sketch of the measures that had been employed at Indore since May last. These were the filling up of anopheles pools, and the improvement of the surface-drainage, the cleaning of ditches and rough-metalling of the bottom of roadside ditches, in the tenacious black-cotton soil. The object aimed at was to make the system of surface-drainage automatic, so as to avoid constant supervision. The destruction of anopheles larvæ by kerosine

and tar was found impracticable, as the larvæ were found sheltering in hoof-prints in the mud at the sides of pools and in ditches. To anoint each of these would have been a labour of Hercules. The compounds of the European residents were inspected and defects were remedied; earthen-made pots destroyed and removed, and fish were placed in those garden tanks which it was found impossible to keep empty. The anopheles larvæ appeared about a fortnight after the beginning of the rains in the beginning of August, and were still to be found in the river pools. A Mosquito Brigade was formed—firstly of students of the Central India Medical school who sought out the breeding places, and secondly of prisoners who did the manual labour involved in the drainage operations. A river passes through the Residency limts and the upper part of this has been transformed into an artificial lake, by means of a "*bund*."* No larvæ were ever found in this. The edges were cut and were kept free from weeds and grass, and fish abound in this water. Below the "*bund*" the edges of the stream form breeding grounds for anopheles, and larvæ were found in myriads. Three old bunds in the course of the stream were repaired and on the deepening of the water channels and clean cutting of the banks the larvæ rapidly disappeared. The indication therefore is to *bund* streams that flow through towns, and to keep the edges of the tanks thus formed as perpendicular as possible and to encourage the breeding of fish.

Further, more attempts were made to diffuse a knowledge of the connection between mosquitoes and malaria by popular Lectures to general audiences both in English and Vernacular, in order to prepare the inhabitants of that portion of the town known as the Residency bazaar to permit of mosquito-destroying operations being carried out in their premises during the coming season. Major Roberts pointed out that the results of his work could not be gauged this year, as owing to the short and insufficient rains of the past season malarial fevers were not as prevalent as is generally the case. The number of cases of fever in the Jail showed a marked diminution as compared with the previous year. In an up-country climate with its characteristic rainy season, clearly defined and limited to certain months, it is possible to expect good results by improved surface-drainage and the prevention of stagnating pools, but in the coast climates with their damp atmosphere, innumerable tanks and ponds, rice-fields, and with sub-soil water near the surface, the problem of mosquito larvæ destruction must be a difficult one.

MAJOR GRANT said that he would begin by mentioning what he considered to be an excellent example *not* of how malaria might be abolished, but of how, within a few years, a place or district previously healthy might become extremely unhealthy from the institution of conditions favourable to the unlimited production of

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*Embankment.

anopheles mosquitoes. Near Madras, about 10 miles to the north, was the former favourite sanitarium of Ennore, originally a fishing village, but largely resorted to by Madras people for many years for boat-sailing, bathing, &c. Even twelve years ago Ennore was still regarded as a perfectly healthy place and it was apparently the general opinion that the strip of country running northward to the Nellore district was an equally healthy area. Gradually, there came rumours of persons getting attacks of fever at Ennore and of salt peons and others getting similar attacks at stations further up the coast. The state of matters rapidly grew worse until the whole area, for some distance in from the Coast line, had acquired a well-earned reputation for producing severe malaria. Captain Giffard, then acting as District Medical and Sanitary Officer of Chingleput District, went into the matter, and, I believe, hit upon the correct explanation of the outbreak or rather general infection. It was impossible to go into details, these would be found in Captain Giffard's original paper, and his observations had been corroborated by other observers. Briefly, the whole of this area was formerly treeless and simple sandy waste. Of late years however, the cultivation of the casuarina tree had been taken up on a large scale and hundreds of square miles, he believed, had been planted. For watering the young trees (? and for planting them) innumerable small pits or holes were dug which contained water for months together. These were almost invariably full of anopheles larvæ : they formed, in fact, ideal breeding places. The outer trees formed a complele protection against the sea breeze so that a few yards within the plantation a lighted match would burn steadily though there was a strong breeze just outside. The malaria had got so bad that people were afraid to live there and the Government of Madras had deputed special officers to see what could be done to lessen the prevalence of the disease amongst the employés at a light-house in the neighbourhood. He recommended Captain Giffard's paper to the notice of the members.

Wet Cultivation.

With regard to wet cultivation within Municipal limits, he was of opinion that the time was coming when the growing of wet crops, such as betel, sugar cane, rice and turmeric, would be altogether prohibited within Municipal limits. This question had come under his notice specially when he was acting recently as Sanitary Commissioner for Madras. The town of Kurnool was formerly very full of malaria, but Lieutenant-Colonel King, the present Sanitary Commissioner for Madras, then District Medical and Sanitary Officer, Kurnool, had managed to secure a prohibition of wet cultivation within a radius of 1 mile from the centre of the town, and for 18 years, or so, this had been carried out, to the marked benefit of the health of the population. Lately, the question was again raised and the speaker made a careful inspection and reported to Government, with the result that a G. O. entirely prohibiting the growth of irrigated crops within the Municipal limits of Kurnool had been issued. Again, in regard to the notoriously malarious

town of Cuddapah, he had just submitted a final report to Government, in connection with certain recommendations made by Colonel King and others, and he hoped to see sanction accorded to the proposals *en bloc* which included amongst other things, the cessation of wet cultivation near the town (previously prohibited for more than 12 years but lately recommended), and the digging of a channel under strict conditions in regard to flow, &c., to assist in freeing the subsoil water, the filling up of a useless channel containing stagnant water and the abolition, if possible, of anopheles pools in the adjacent river, &c., &c.

He considered it worthy of note that the town of Vellore, apparently owing to its being situated on a good slope and the soil particularly well-drained by natural means, appeared to be almost free from malarial fever. At the same time he admitted that 'general impressions' were of little value and that nothing but careful and special investigation would settle a matter of this kind one way or the other.

MALARIA IN TOWNS.

Another point on which emphasis required to be laid in considering the general question of malaria prophylaxis was the prevalence of severe malaria in some of the largest and oldest towns in India. A perusal of the general literature dealing with malaria in India, prior to a year or two ago, would lead one to imagine that the disease was almost confined to jungly or swampy areas and was essentially a rural disease; and the same idea was very generally prevalent amongst medical officers. This, however, was not by any means the case. Lieutenant-Colonel King had pointed out in his valuable inspection notes on the towns of Madras some years ago that malaria of a virulent type was prevalent in that city, and that the fact had been borne in upon him by his experience when Second Physician at the General Hospital. Speaker had held the same post for ten years and found this to be an easily-ascertained fact; and noticed, further, as a result of his hospital experiences, private practice and enquiries from Medical practitioners and old residents, that Madras has been gradually getting worse instead of better in this respect, as he had pointed out elsewhere. The latter assertion had been disputed, but there was not the slightest doubt about the matter, either as to the occurrence of primary attacks or as to the increasing frequency of malarial fevers in Madras. Just before leaving Madras to attend this Conference an English merchant had informed him that a village close to Madras had been practically deserted by its occupants owing to the fearful fever which had become prevalent. Whilst those residents who live in the better portions of Madras and in large houses in big compounds were almost free, as also, to a considerable extent, those who slept on the second floor in Blacktown, &c., the general population of Blacktown suffers terribly and malarial cachexia in its extreme expressions is rife amongst them and occasions a very large mortality, directly or indirectly. There were many other points of interest which might be alluded to, but he would conclude by stating his agreement

with the suggestion that much good might be done by simple instruction on the subject to students and others. Medical Officers in Madras frequently gave lectures on subjects connected with health, and Captain Giffard delivered a most interesting lecture, with the speaker as chairman, some time ago, to the members of the Presidency College Literary Society, on the relation between mosquitoes and malaria.

RECOMMENDATIONS REGARDING THE PREVENTION OF MALARIA

MADE BY THE SUB-COMMITTEE OF THE MALARIA CONFERENCE

HELD AT NAGPUR IN JANUARY 1902.

The Sub-committee of the Malaria Conference (consisting of representatives from the various provinces of India, together with Dr. Christophers and Captain James of the Malaria Commission), having been asked by the Conference to draw up recommendations, for submission to Government, regarding the best measures which can be taken in India for the diminution of malaria, beg to submit the following:—

A.—Measures which should be taken in Cantonments.

1. As malaria depends very much on conditions which differ locally, and thus measures which can be applied to one place are unsuited for another, we are of opinion that, in cantonments which are especially malarious, an officer with a special knowledge of malaria should be deputed to investigate the local conditions. Such an officer would be in a position to make practical suggestions, which could be easily carried out.

2. As anopheles mosquitoes largely develop on the banks of "kutcha" irrigation-channels and ditches, we are of opinion that much diminution of fever would result if all irrigation-channels within cantonments were lined with masonry, and we recommend that—as an experimental test—all irrigation-channels throughout one cantonment (as Mian Mir or Peshawar) be lined with masonry.

3. As anopheles mosquitoes chiefly become infected with malaria in native houses, and as malaria among European troops is chiefly due to the vicinity of native huts (or small bazaars) to the barracks, we are of opinion that such

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NOTE.—"Pukka"=masonry; "kutcha"=non-masonry.

collections of huts or bazaars (however small) should be removed from the vicinity of barracks to a distance. Sometimes these huts are few in number and seem unimportant, but as a matter of fact they form a source of infection of the troops.

4. As Sadar Bazaars tend to increase in population, and to become unduly extended, we are of opinion that stringent measures should be taken to limit the population, as far as possible, to those who have dealings with the troops.

5. As small ponds and ditches near inhabited sites form good breeding-places for mosquitoes, we recommend that all cantonments should pass a bye-law, which should be strictly enforced, that no person be allowed to excavate earth (whether in a private compound or not) within cantonment limits. This bye-law should be especially applied to prevent road repairers and workmen of the Military Works Department from making "borrow-pits" at road sides.

6. As many pools already exist, we recommend that each cantonment authority should order the Health Officer to make a list of small ponds within cantonment limits (whether in private compounds or not) and that, where practicable, such ponds should be filled up.

7. As in some cantonments a small stream or drying up river is one of the chief sources of malaria, we recommend that these should receive the especial attention of local officers.

8. As overcrowding in the houses of the native servants of Europeans is a great predisposing cause of malaria, we recommend that a bye-law, to control the number of servants living in Europeans' compounds, be passed by all cantonment authorities.

9. As anopheles larvæ largely develop in "kutcha" drains at roadsides and such drains are the principal sources of anopheles mosquitoes, we are of opinion that "pukka" drains are most important, and recommend that all roads throughout cantonments be provided with "pukka" drains in the vicinity of barracks and of the Sadar Bazaar.

10. As "wet cultivation" (as of rice and sugar-cane) within cantonment limits is a great predisposing cause of malaria, we recommend that a bye-law should be passed in all cantonments prohibiting it, but not interfering with gardens.

11. We recommend that instructions for the prevention of malaria be issued to all cantonment authorities, and beg to submit in Appendix A, a draft of instructions.

B.—Measures which should be taken in Municipalities.

1. As the local conditions, which predispose to the continuance and spread of malaria vary very much, we are of opinion that no definite specific

orders on the subject should be issued to municipalities. More benefit would accrue from the visit of an officer with a special knowledge of malaria, who could enquire into the special local conditions and could then make definite practical suggestions. We recommend that an officer with such special knowledge be detailed to visit municipalities and report on the special causes of malaria in these. In the meantime any sanitary measures which are in progress may be continued.

2. As brick and tile-making and quarrying cause numerous ponds to be made, which are very suitable breeding-grounds for mosquitoes, we recommend that these occupations be classified as dangerous trades, and that local authorities be asked to regulate and control them, so that they may not be carried on near inhabited areas, and that they be allowed within cantonment limits only with the express permission of the Sanitary authority.

3. We recommend that each municipality should prepare a list of the small ponds and pools which are within its limits, and that steps should be taken to have these filled up. This should be done yearly. Tanks should not be included in the list, as these only need to be cleaned out once or twice a year.

4. As bad surface-drainage in municipalities is one of the chief causes of the continuance and spread of malaria, we recommend that each municipality should prepare, and keep ready for use, plans and estimates for a complete system of surface-drainage throughout the whole town. The surface-drainage should be gradually carried out from year to year as money is available. The works should be commenced at the outfall, and the most unhealthy and crowded areas dealt with first.

5. As bad drainage round hydrants causes the formation of numerous anopheles pools in municipalities, we recommend that no water-works scheme should receive sanction unless it also contains plans, estimates and an allotment for efficient surface-drainage from all hydrants, so that the waste water may be properly carried to the general surface drainage system.

6. As anopheles mosquitoes especially develop at the grassy sides of "kutcha" drains and ditches, we think that much good would result in municipalities, where "pukka" drainage is not yet complete, if a gang of coolies were sent round under the guidance of a Health Officer just before and during the rains, to clean out all such ditches—by scraping their sides, and removing the grass and, as far as possible, filling up irregularities.

7. As irrigated crops are a cause of the continuation and spread of malaria, we recommend that a bye-law should be passed in all municipalities prohibiting "wet cultivation" within half a mile of inhabited areas.

8. With reference to Major Ross's proposition to employ "Mosquito Brigades," we are of opinion that the work done by such brigades would be of great value; but, as prejudice is so easily aroused in native communities, action on his proposition should be taken with very great caution.

9. We recommend that instructions for the prevention of malaria should be issued to all members of Municipal Boards and Councils for their general guidance. Such instructions to be based on those set forth in Appendix B.

C.—General Recommendations.

1. As malaria is the most important disease in India, we recommend that Government medical colleges be asked to institute classes for the practical training of subordinates in the examination of the blood, the nature of the malaria parasite, and the finding of anopheles larvæ.

2. We recommend that a course of Elementary instruction regarding the natural history of the mosquito and its influence on malaria, be introduced into Government schools.

3. As all authorities are of opinion that small doses of quinine have no prophylactic or curative value whatever, we recommend that the sale of 5-grain packets at post offices, police stations and schools, be discontinued, packets containing at least *10 grains* being substituted. This increased dose is more effectual and—in the end—more economical.

4. As the practice of giving only one dose of quinine every morning to out-patients at dispensaries is not a good one, we recommend that Hospital subordinates should be ordered to give a 3 days' supply of quinine to every out-patient who is found to be suffering from malarial fever.

5. When the issue of quinine as a prophylactic is made to troops or prisoners, we recommend that the dose be not less than 10 grains, that it be given twice a week, and that its administration should be carried out under the personal supervision of a commissioned Medical officer.

6. We recommend that Administrative Medical Officers should, previous to the seasonal incidence of malaria, see that there is a sufficient supply of quinine at all dispensaries in their districts.

7. As the quantity of quinine used annually in Hospitals and Dispensaries, is often very inadequate to the needs of the people, we recommend that Medical Officers and Civil Surgeons should be allowed as much quinine as they require,

8. In our opinion Cinchonidine Sulphate, Cinchona febrifuge, and the Cinchona Alkaloids are all of little, if any, value, we recommend that Government Depóts cease to issue these.

9. As cases of malaria can be lessened in number, by personal attention to details within a house, as well as to minor insanitary conditions in its vicinity, we recommend that instructions regarding the prevention of malaria be issued for the use of private individuals. We submit, in Appendix C, a draft of such instructions.

(SIGNED.)
H. K. MCKAY, LT.-COL. I. M. S., *Central Provinces.*
A. E GRANT, MAJOR I. M. S., *Madras.*
G. T. BIRDWOOD, CAPTAIN I. M. S., *N. W. Provinces.*
R. HEARD, CAPTAIN I. M. S., *Punjab.*
S. P. JAMES, CAPTAIN I. M. S., *attached to Malaria Commission.*
LEONARD ROGERS, CAPTAIN I. M. S., *Bengal.*
GLEN LISTON, CAPTAIN I. M. S., *Bombay.*
S. R. CHRISTOPHERS,—*Royal Society's Commissioner.*

Appendix A.

PREVENTION OF MALARIAL FEVER.

GENERAL RULES FOR THE PREVENTION OF MALARIAL FEVER FOR THE GUIDANCE OF CANTONMENT AUTHORITIES.

DRAWN UP BY THE MALARIA CONFERENCE HELD AT NAGPUR IN JANUARY 1902.

It has now been definitely proved that Malarial fever is spread by the bite of a mosquito, of the anopheles variety. By taking certain measures, the number of mosquitoes in a cantonment can be much reduced, and the incidence of fever diminished. The chief conditions which favour the spread of malaria in cantonments are :—(1) bad surface drainage; (2) unnecessary pools and small accumulations of water ; (3) the existence of natives' houses in the vicinity of barracks.

1. *Pools and puddles in cantonments.* In many compounds of cantonments small ponds are found. These are generally formed by the landlord to obtain earth to repair the stables and servants' houses; they form most suitable places for the development of mosquitoes. The cantonment Health officer should be sent round to make a list of these ponds and they should be filled up. Strict rules should be made prohibiting such excavations within cantonment limits.

2. *Ditches near barracks.* Any ditch near barracks which contains water forms a suitable breeding place for mosquitoes. Several barracks may be infected from one small focus. All such ditches should, if possible, be done away with; if this be not possible, they should be cleaned out regularly or else made "pukka."

3. *Ponds are frequently found near Native Regimental lines.*—The houses in the lines are annually repaired by taking earth from these ponds. They are probably a source of fever to the whole Regiment. It is most necessary, for the health of the Regiment and Cantonment generally, that all such ponds should be filled up. Earth for repairing the line should be obtained at a distance from any inhabited site.

4. *Good surface drainage at the sides of the roads* in the Sadar Bazaar and throughout Cantonments generally, is a matter of great importance. Mosquitoes breed freely on the grassy side of a "kutcha" drain but they seldom breed in "pukka" masonry drains, therefore the making of good "pukka" surface-drains at the sides of all roads in Cantonments should be insisted on. Water should not be allowed to remain stagnant at any point along them or under bridges and culverts. Ditches which cannot be made "pukka" should be regularly cleaned and freed from grass, especially just before and during the rainy season.

5. It frequently happens that roads in Cantonments are repaired by earth being dug from the sides of the road, and thus pools are formed, and the surface drainage interfered with. Such excavations at the side of the road within cantonments should be strictly prohibited.

6. *Surface drainage round wells* is often very defective. Waste water accumulates and stagnates near the well mouth and thus good mosquito breeding places are made. Therefore, great attention should be paid to surface drainage round wells. All wells in cantonments ought also to have a good close-fitting cover.

7. *Surface drainage round hydrants* and standposts is often very defective; from the constant dripping of the taps waste water accumulates, and no attempt being made at surface drainage, numerous mosquito pools are formed. Good "pukka" surface drains should carry the water well away from every hydrant into a definite system of surface-drains.

8. Medical officers with Corps should regularly search for mosquito breeding places in the neighbourhood of their lines and barracks. If any such pools are ound, the medical officer can either deal with them himself or ask the Cantonment Magistrate to do so.

9. If fever prevails exceptionally in any barrack or set of buildings in Cantonments, the Health Officer should explore the neighbourhood in search of mosquito breeding places which are the source of the danger. These, when found, should be suitably dealt with.

10. A common insanitary condition predisposing to the spread of malarial fever is *overcrowding among native servants in officers' compounds.* When several officers share a bungalow this overcrowding is often very bad. It is advisable that Cantonment authorities should do what they can to regulate and reduce this overcrowding.

11. Officers Commanding Native Regiments should have the *interior* of the houses in the lines whitewashed every 3 months. Anopheles mosquitoes rest on the inner side of the dark roofs of native houses, and frequent thorough cleansing would probably much diminish their numbers.

12. The issue of quinine as a prophylactic to Troops and to Commissariat and Transport followers is strongly recommended whenever fever is prevalent. The doses should be not less than 10 grains and given twice a week—the present method of giving small doses is useless. The administration should be under the personal supervision of a commissioned medical officer.

13. The sale of quinine should be permitted and encouraged in every way at thanas, post offices, and octroi posts of Cantonments, and in packets of not less than 10 grains.

14. A liberal grant for quinine should be allowed to the Cantonment General Hospital.

15. Overcrowding and insanitary conditions in the Sadar Bazaar should receive attention, as it is not improbable that soldiers frequently get infected with malarial fever when visiting the bazaar.

16. As the population of Sadar Bazaars tends to increase very much, the inhabitants should, as far as possible, be limited to such people as have direct dealings with the troops.

17. In some cantonments, small native houses exist in the vicinity of barracks. These houses should, as far as possible, be cleared away, and strict precautions taken that no huts or sheds be erected in the vicinity of barracks. The regulations of the Cantonment Code on that point should be strictly adhered to, and, if possible, retrospectively applied.

18. The cultivation of crops requiring irrigation (as rice and sugar cane) should be strictly prohibited within cantonment limits. This suggestion does not apply to gardens.

19. Punkah coolies are a great danger; the pulling of punkahs by mechanical means should be introduced as soon as possible.

Appendix B.

PREVENTION OF MALARIAL FEVER.

GENERAL RULES FOR GUIDANCE FOR THE PREVENTION OF MALARIA IN MUNICIPALITIES, FOR THE USE OF MEMBERS OF MUNICIPAL BOARDS AND COUNCILS.

DRAWN UP BY THE MALARIA CONFERENCE HELD AT NAGPUR IN JANUARY 1902.

It has been definitely proved that malarial fever is spread from one person to another by the bite of a mosquito (of the anopheles variety). It is the prevalence of this mosquito near inhabited sites which causes the high incidence of fever in our municipalities. A knowledge of the habits of this insect has taught us the conditions, which are favourable for development, and there are many such conditions in Indian municipalities. Some of these are more prevalent in one municipality than another. If we take steps to alter them, the amount of fever will be considerably reduced. The following instructions for dealing with these conditions have therefore been drawn up. They come chiefly under two heads:—(A) Bad surface drainage, (B) Unnecessary ponds, ditches and accumulation of water.

1. The *surface-drainage in the vicinity of municipal wells* is often very bad. Waste water is allowed to stagnate near the well or to flow down into the side of the street and form a small morass. All such collections of waste water form mosquito breeding pools. It is therefore very important that good surface-drainage should be provided in the vicinity of wells.

2. In municipalities where there is a pipe-water supply, there is frequently very *bad drainage round the hydrants*. Waste water collects round the hydrants and forms pools and puddles, which become good breeding places for mosquitoes

and foci for the spread of malaria in the municipality. Therefore, thoroughly good surface-drains should be made round every hydrant which should be in connection with a general system of surface-drains.

3. *Good pukka surface drainage at the sides of all streets and roads* in the municipality is of great importance. Mosquitoes are found to breed readily in "kutcha" drains, while they scarcely breed at all in masonry or "pukka" drains. Therefore "pukka" surface-drainage is one of the first principles of malaria prevention. The chief streets of a municipality are generally well drained, but in the outlying roads and streets drainage is often bad, and many mosquito pools are formed. Municipalities therefore should institute "pukka" surface drainage throughout its area.

4. It is recommended that municipalities should have a general survey for a complete scheme of surface-drainage made by a competent Engineer. As money becomes available, this scheme should be carried out from year to year, the work being commenced at the outfalls.

5. After drainage, *unnecessary ponds and pools* near inhabited sites need most attention. These ponds in municipalities asise from various causes :—

(1) Landlords and householders form them by digging earth to repair walls and houses, or to build new houses.

(2) Brick and tile-makers form them by digging earth and clay.

(3) Contractors for repairing roads form them at the sides of roads by digging earth to bank up the road.

(4) Railway authorities form them to make embankments.

All such ponds and pools give opportunities for breeding to the mosquito. They are a great source of ill health, and *every opportunity should be taken to have them filled up*. Municipalities should try as much as possible to prevent any ponds being formed within municipal limits.

6. "Wet cultivation" should not be allowed in municipalities within half a mile of inhabited sites.

7. If fever is exceptionally prevalent in certain mohullas or groups of houses, the *Health Officer should be asked to make a special search* for mosquito breeding pools in the affected area, and these should be suitably dealt with, when found.

8. *Packets of quinine containing at least 10-grain* doses should be sold at low rates at post offices, thanas, octroi posts and schools.

9. The supply of quinine to municipal dispensaries should be very liberal A special allotment from municipal funds might be made for this. Patients coming from a distance should be allowed to take away a large bottle of quinine mixture, at least sufficient for 3 days.

10. Native gentlemen might be asked to bring to the notice of the Civil Surgeon or District Sanitary officer any insanitary condition in the neighbourhood of their houses.

11. The principles detailed above, with reference to ditches, pools, ponds and surface-drainage, also apply to the Police lines and all the precincts of the Civil station.

12. In some municipalities small streams running near or through the town form the chief breeding place of the mosquitoes and therefore need careful attention. Some action should be taken to keep them flushed or to clean them out. The advice of an officer with special knowledge should in most cases be taken as to how best such streams should be treated.

13. The members of Municipal Committees should be requested:—

(1) To improve the condition of their servants' houses and to see that they are not unduly crowded.

(2) To see that their compounds and the surroundings of their houses are kept as clean as possible, especial attention being paid to the clearing away of old tins, pots and pans.

(3) To fill up or drain all small pools, ponds and collections of stagnant water near their houses.

They should also be requested to use their influence among their friends, neighbours and acquaintances, to the end that these may follow their example.

Appendix C.

PREVENTION OF MALARIAL FEVER.

INSTRUCTIONS FOR THE GUIDANCE OF PRIVATE PERSONS.

DRAWN UP BY THE MALARIA CONFERENCE HELD AT NAGPUR IN JANUARY 1902.

It has been definitely proved that malarial fever is spread from one person to another by the bite of a mosquito (of the anopheles variety). By diminishing

the numbers of insects in one's house, one's chances of catching malarial fever are much reduced. A knowledge of the habits of this mosquito has taught us the measures to adopt in order to diminish their numbers, and thus protect ourselves to a certain extent from being bitten. The following instructions are drawn up for the guidance of private persons who wish to adopt these measures and to render their homes more healthy and free from fever :—

A.—Precautions which should be taken inside the house.

1. The proper use of the mosquito net is the best and surest prophylactic measure that we have. The net should be of a small mesh and should be tucked in carefully all round the bed. If rods are used it should be hung inside them.

2. During the rains, and whenever fever is prevalent, each member of your household, including *your servants, should get* 10 *grs. of quinine twice a week* (say on Tuesday and Friday mornings). It is best to buy a large bottle of 5-grain pills (or powders) and to give two pills (or powders) to each servant. The money will be well spent in that it prevents fever occurring among the members of your household and being conveyed to others by the mosquito.

3. The *general cleanliness of your house should receive much attention.* It is found that mosquitoes rest in dark and dusty corners. The cleaner the house the fewer the mosquitoes.

4. It is advisable to have *as few curtains and as little drapery in a house as possible* as they harbour mosquitoes. Curtains should be light in colour and of a washable material.

5. With regard to children : on their going to bed, it is advisable *to anoint their legs, arms, foreheads and necks* with oil of eucalyptus, or menthol and vaseline or carbolic oil, and also, when washing them, to use turpentine soap, as such measures tend to keep off mosquitoes.

6. Careful attention should be paid to water receptacles in bathrooms and around the house. It is not advisable to keep "garrahs" or "chatties" full of water in the bath-room. Those in use should be emptied daily. Especial attention should be paid to the "garrahs" kept for cooling soda water.

B.—Precautions which should be taken outside the house.

1. Small "kutcha" ponds and ditches exist in many gardens and compounds in India, and are generally the breeding places of mosquitoes, which, when mature, readily fly into the house. These ponds are often made by the landlord when he repairs the stables or servants' houses. Therefore, one of your first measures should be to *have all ponds and ditches near your house filled up.*

2. Frequently there lie near the kitchen and out-houses old pots, kerosine tins, and other receptacles for water; a careful search for these should be made, and, if found, they should be removed or destroyed.

3. The next point which should receive your attention is *the surface-drainage round the house*. Frequently only "kutcha" surface-drains are found. When these are out of repair, stagnant water will accumulate during the rains. To obviate this, good small "pukka" surface drains should carry the water well away on every side.

4. A systematic weekly inspection of the vicinity of the kitchen, servants' houses, and compound generally should be made.

5. The surface drainage round the *mouth of the compound well* is often very bad. Waste water accumulates there and anopheles pools are thus formed. You should therefore get a good "pukka" surface drain to carry off all waste water from the well and distribute it to the garden. The well should be protected by a good close-fitting cover.

6. The system of flower-garden irrigation tends to form pools where mosquitoes can breed. It should not therefore be carried out close to the house, and any small tanks or reservoirs in the garden when not in use should be treated with half a tumblerful of kerosine oil once a week, as this procedure stops the development of mosquitoes in them. These tanks should be covered with close-fitting covers. All garden irrigation should be carried out by means of "pukka" masonry channels.

7. *Excessive vegetation and undergrowth* should not be allowed to exist near the house. Anopheles mosquitoes prefer cool dark places for resting in during the day, so that excessive vegetation should be cleared away from near the doors and windows of sleeping rooms.

8. It is important to pay attention to the *cleanliness of your servants' houses and their vicinity*. Native servants frequently suffer from fever, and mosquitoes haunt their dark ill-ventilated houses. The following points need attention :—

(1) There is frequently a *ditch or pond near the servant's house*, where the mosquitoes breed. This should be searched for and filled up.

(2) The houses of servants, especially menial servants, syces, and grass-cutters, are frequently *overcrowded*. As few servants as possible should be allowed to live in the compound.

(3) *Servants' houses should be thoroughly cleaned out and white-washed twice* a year. Personal attention to the surroundings of your servants will well re-pay the trouble, as you will not only have healthier and happier servants, but the members of your family will run less risk of catching fever.

SECTION VI.

RESOLUTIONS

Passed by the Malaria Conference which met at Nagpur on 2nd January 1902.

I.—TYPHOID FEVER.

1. The members of this Conference are unanimously of opinion—

(*a*) That the prevalence of typhoid fever amongst the natives of India has been proved beyond all doubt;

(*b*) That this disease is of common occurrence and is not to be regarded as exceptional in any sense;

(*c*) That it affects persons of every class, caste and age and that the idea of the vegetarian being exempt is purely fanciful;

(*d*) That whilst a double infection of typhoid *and* malaria, as of malaria and other diseases, *e. g.* pneumonia, is by no means uncommon, the so-called disease *typho-malaria* has no existence in fact;

(*e*) That inasmuch as it appears certain that so-called 'ambulatory' cases of typhoid in which the fever may be slight as to degree, duration, or both, do occur, and may constitute a source of great danger to the patient or others, if the disease is not recognised, it is of the highest importance that every available means of diagnosis, and specially the Widal test, be made use of as a matter of course.

II.—NOMENCLATURE.

(i.) This Conference is of opinion that the present classification under which the official returns for malarial disease are made, in accordance with *The Nomenclature of Diseases*, is now inaccurate and misleading, and that an altered classification is imperatively and urgently called for. It therefore recommends that for

Malarial fever—
a. Intermittent. *Synonym*, Ague
b. Remittent

the following be substituted, *viz.*:—

Malaria—
a. Fever.
b. Cachexia. *Synonym*, Chronic Malaria.

(ii.) It is further of opinion, that although the life history of the malaria parasites is well understood, yet the lack of the means for correct diagnosis in the majority of hospitals in India renders it inadvisable to adopt, at present, any other than the simple classification above suggested. At a later date, when the means essential for accurate diagnosis have become generally available, it will be necessary in order for correct returns, to adopt a more detailed and scientific classification depending upon the presence of the specific parasite of each variety of fever.

(NOTE.—Dr. Powell dissents from this Resolution).

III.—TEST EXPERIMENTS.

We further recommend that each Local Government and Command should carry out test experiments in favourable localities under different conditions, such as Municipalities, Jails and Cantonments, under special Medical officers, with sufficient funds, so as to furnish convincing object lessons of the value of the new prophylaxis in the prevention of malaria, which will encourage local bodies to do all they can to obtain similar good results.

IV.—PRISONERS.

The Members of the Conference take this opportunity of placing on record their recognition of the valuable services performed by the Burmese prisoners 5892 Ko Tha Aung, 5410 Nga Weh Kyi, 2220 Nga Kyi, 1363 Nga Pe Gyi, 6539 Nga Hman, and by 6757 Goverdhan, a native of India. The men had been

previously trained by Major Buchanan and have now become most efficient microscopists and observers while their general knowledge of the subject of Malaria, but especially the bacteriological part of it, is remarkable. It is no exaggeration to say that the assistance rendered by the prisoners referred to has, in a large measure, contributed to the success of the Conference, and that their familiarity with laboratory technique tended to lighten considerably the amount of work which had to be undertaken. The Members of the Conference would suggest that these facts should be brought to the notice of the Government of India, through the proper channel with a view to the term of the men's sentences being reduced, if possible; and further that, if released, their special qualifications might be utilised by offering them service in already existing laboratories or in others which it may be intended to establish.

(Signed.)

A. Scott Reid, Col. I. M. S.
W. A. Quayle, Lt.-Col. I. M. S.
H. K. McKay, Lt.-Col. I. M. S.
G. D. Bourke, Col. R. A. M. C.
A. E. Grant, Major I. M. S.
A. G. Hendley, Major I. M. S.
H. E. Banatvala, Major I. M. S.
J. R. Roberts, Major I. M. S.
R. R. Roe, Lt.-Col. I. M. S.
A. Buchanan, Major I. M. S.
G. T. Birdwood, Captn. I. M. S.
R. Heard, Captn I. M. S.

(Signed.)

S. P. James, Captn. I. M. S.
W. D. Sutherland, Captn. I. M. S.
P. F. Chapman, Captain I. M. S.
N. Rainier, Captain I. M. S.
Leonard Rogers, Captain I. M. S.
Thos. Jackson, Captain I. M. S.
G. Lamb, Captain I. M. S.
Glen Liston, Captain I. M. S.
Arthur Powell.
S. R. Christophers. } Royal Society
J. W. W. Stephens. } Commissioners.
E. H. Aitken.

SECTION VII.

MISCELLANEOUS.

SNAKE VENOMS: THEIR PHYSIOLOGICAL ACTION AND ANTIDOTE.

BY

GEORGE LAMB, CAPTAIN, I. M. S.

(*From the Research Laboratory, Bombay.*)

WHEN Major Buchanan asked me if I would read a paper on the action of snake poisons before a popular meeting of the Malaria Conference —what snake venom has to do with malaria I leave Major Buchanan to explain—I readily acceded to his request. For is it not to the energy and enthusiasm of our worthy president, Colonel Scott Reid, and of the Civil Surgeons of the Central Provinces that I owe the ways and means of carrying out the experiments and observations, a summary of which I propose to lay before you this evening. Without their able assistance in procuring and sending me snakes, the hens that lay the golden eggs, I should certainly not be in the position I now occupy. At the same time however I little thought, when I promised Major Buchanan, of the difficulties which lay before me. For we are here dealing with a subject which is full of what I might call technicalities, possessed like malaria with a language peculiar in a way to itself, known only to the workers on the subject and of which the medical man and the public have little or no cognisance. Further, investigators have by no means arrived at any absolutely definite conclusions as to the exact methods by which the various snake poisons cause their lethal actions; that they do differ in this respect there can however be no possible doubt. It is

therefore you will readily imagine a subject around which controversy still runs high. Every day new facts are being brought to light, new hypotheses are being expounded and old theories exploded. I have also to remember that to some of you at least the subject is a new one : that, it may be the extent of your knowledge is limited to appreciating that there are some snakes which secrete a poisonous saliva while there are others which have not this function. Such then, ladies and gentlemen, are some of the difficulties which surround me and I have therefore to crave your indulgence should I wander and ask you to indicate to me in some way or other your disapproval of such.

It is not my intention to enter into the question of the differences by which naturalists know a poisonous from a non-poisonous snake. In fact I am not competent to do so. Snakes of which there is any doubt arriving at our laboratory are at once sent for identification to Mr. Phipson of Natural History Society.

There are many varieties of poisonous snakes in India; but you will no doubt be glad to hear that of these only four—I talk of the terrestrial snakes—can be said to offer any danger to man. Naturalists divide these into two great groups—*viz.* (1) two of the Colubrine variety, *viz.* the Cobra and the Kraits. (2) Two Viperine, *viz.* Russell's Viper or Daboia and Echis Carinata or Phoorsa.

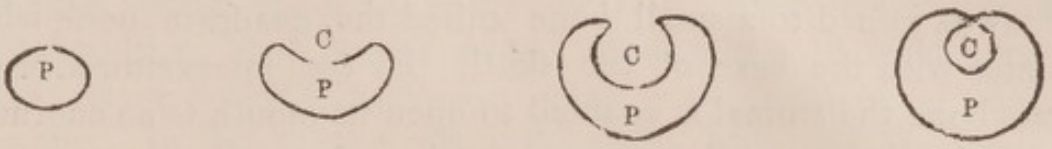
The saliva of the other varieties which are poisonous is either not strong enough or not plentiful enough to cause a fatal result in man. At the outset however I should like you to understand that my remarks on the physiological action of these poisons will be strictly confined to a summary of the observations which I have made with the venoms of the two most deadly of these snakes, *viz.* the Cobra and the Daboia. I have little or no experience of the poison of the Kraits or of the Echis nor do I know of any thoroughly trustworthy scientific observations which have been made with the poisons of these two varieties. And let it be clearly understood that although the Krait is a colubrine snake and Echis a viper it by no means follows, as I have good reason to know, that the poison of the Krait has the same physiological action as the venom of the Cobra or that of the Echis the same as the venom of the Daboia.

Poison apparatus and the mechanism of the Bite.

The poison of snakes is secreted by two glands, one on each side of the head, which are the homologue of the parotid salivary glands of other vertebrates. These glands are situated behind the orbit, quite superficially beneath the skin. As you can see in this specimen of a Cobra's head they are about the size of and somewhat resemble in shape an almond. Each gland is enclosed in a dense fibrous capsule which serves as an attachment to the muscle, which, as we shall see, compresses the poison out of the gland. This muscle is the masseter muscle. It assists powerfully in closing the lower jaw. You will see from this dissected specimen and from this diagram that it is divided into two portions. The upper portion arising from the skull along a curved line behind and above the orbit passes downwards and backwards to be inserted along the upper and posterior margin as well as to the external surface of the capsule : it envelopes the gland above and behind. The lower portion arises from the internal surface of the gland capsule at the back part and widening out passes down to be inserted into the lower jaw. When this muscle contracts, as it does powerfully when the snake closes its jaws on its prey, you will see that the poison gland is, as it were, forcibly wrung between these two portions of the muscle, much in the same way as a housewife wrings a wet cloth between her hands. In this way the poison is ejected into the duct at the right moment, *viz.* when the fangs are buried and ready to convey the death-dealing dose.

From the front portion of the gland the poison duct passes forward, runs along the lower margin of the orbit and opens on the top of a small papilla or eminence which is situated at the base of the fang on the anterior wall of a sheath of mucous membrane which embraces the fang. This duct therefore is not directly continuous with the canal of the poison fang. We shall see in a moment how no leakage of the poison takes place at this junction.

The fang as you no doubt know is nothing more or less than a tooth which has undergone a special development, so that it may act as a functional tube to convey the poison into the wound which it inflicts. Let us look for a moment at this development.



After Martin of Melbourne. After Martin of Melb urne. After Martin of Melbourne.

C—Canal for poison.

P—Pulp cavity.

A tooth as you are aware consists of a central cavity, the pulp cavity, containing vessels and nerves and of an outer hard shell covered over on the outside with enamel. Such is the structure of the poison fang in a young snake (fig. 1). During development it becomes flattened out and soon a groove appears on the anterior surface. This groove is limited on each side by a ridge, (fig. 2). Then these ridges by a process of folding over of the whole tooth approach one another anteriorly (fig. 3) and ultimately are brought into contact and coalesce. Thus from the diagram (fig. 4) you will see that there are now two complete cavities in the poison fang, *viz.* (1) the original pulp cavity and (2) the new poison canal situated in front of the pulp cavity. But at the base and near the point of the tooth this folding over is not completed. We have left there the opening by which the poison enters the fang from the duct and the opening by which it leaves the fang. These openings you will understand if you have followed me are not at the two very extremities of the fang but are situated anteriorly a little short of the base and of the point respectively. I pass round the fangs of a Daboia, so that you may see this more clearly.

The fangs, which are functioning, are completely ossified, that is joined by bone, to the upper maxillary bone or upper jaw. How then does it come about that what is known as erection of the fangs takes place? for as you are no doubt aware while the mouth is shut and at rest the fangs lie along the roof of the mouth pointing almost straight backwards. To make this interesting mechanism clear to you, we shall have to consider for a moment the structure of the bones on the roof of the mouth, that is the upper jaw. Here we have a rough cardboard model of one side of a snake's skull. You will first of all see that the

lower jaw is joined to a small bone called the quadrate bone which articulates with the base of the skull. By the intervention of this quadrate bone the animal is enabled to open its mouth to an enormous extent so that it can swallow large animals such as pigeons, hens, rats, &c.

From this model you will also see that the upper jaw is formed of the following parts—(I am speaking now of the cobra's skull) (1) a bone called the pterygoid bone behind. This passes forward and divides into two short limbs which I have represented here. Each limb is articulated to a bone in front—thus the outer limb is joined to (2) the maxillary bone which carries the poison fang and the inner limb is joined to (3) the palatine bone which carries a row of ordinary teeth. These two bones, the maxillary and the palatine, are fixed in front to the under surface of the skull by joints which permit of a certain amount of gliding. The whole bar is freely movable backwards and forwards. Now when at rest this palatine bar is kept back so that the fangs lie pointing backwards along the roof of the mouth. When the fangs are to be erected what happens is this. The bar is pulled forward by two muscles, the parieto-pterygoid and the spheno-pterygoid, which I have represented by these pieces of ribbon. The forward movement is however soon stopped by a strong ligament at the front joints. Then bending takes place at the joints between the pterygoid and the front bones of the bar and the maxillary bone carrying the fang rotates and the fang presents in a more forward direction. This mechanism is, I think, you will acknowledge a very neat one.

I told you before that the poison duct ended on a papilla on the anterior wall of the mucous sheath which covers the fang and that the opening of the canal in the fang is situated on the front surface near the base. When the fangs are lying at rest pointing backwards the joint therefore between the poison duct and the fang channel is a leaky one—there is a break in the continuity of the canal which is to convey the venom. This must be closed in some way or other when operations begin. It is done in this way: when the fang becomes erected the papilla on which the duct opens becomes apposed to the opening at the base of the fang—it fits loosely into this opening. The joint is then made perfectly tight by the stretching of the mucous

membrane sheath which embraces the fang. Each side of this sheath is attached to a band which passes back to the internal pterygoid muscle (shown in this dissection) a muscle which assists in closing the lower jaw. In this manner when the snake bites and the jaws close tightly the sheath is pulled backwards and the papilla is at the right moment forcibly held in its position in the aperture of the tooth. The aperture, as Martin of Melbourne puts it, is as it were by this means actually corked.

Thus to sum up, we have seen that when a snake bites the poison is forcibly ejected from the glands deeply under the skin of its prey. Two of the muscles which close the jaw are the muscles which are instrumental in this ejection : thus while the masseter muscle compresses the glands, wringing the poison out of them, the contraction of the powerful internal pterygoid ensures that the canal is a continuous one and that therefore there is no wasting of the precious material on its way to bring a meal to the striker.

On the method of procuring the poison for Experimental purposes.

All the older experiments with snake venom were made by allowing the snake to bite some animal or other. This method is of course a crude one and affords us no information as to the amount of poison which a snake can inject or as to the exact quantity which can prove lethal to a given animal. Nowadays all investigators work with dried and weighed quantities of venom. The poison may be collected in one of two ways:—(1) The snake is allowed to bite through a piece of rubber stretched over a watch glass or other suitable receptacle or (2) the snake is caught by means of a guillotine arrangement or a strong pair of forceps, behind the neck. If these are not available, a trained snake man will serve the purpose equally well. The animal caught in either of these ways is then securely held with one hand behind the head. The lower jaw is then forcibly opened by catching the skin covering it. The fangs become erected and the duct continuous. In the case however of the Daboia, which has exceptionally long fangs, it is well to pass a piece of string behind them and pull them forward with this. With the finger and thumb of the other hand firm and steady pressure from behind forwards is made over the glands behind the orbits. The poison escaping from the fangs is caught in a watch glass held by an

assistant in a pair of long forceps. The process is, you will understand, a process of squeezing, not, as we sometimes call it, one of "milking." The liquid poison is then quickly and thoroughly dried over lime or sulphuric acid. I have carefully estimated the average amount of venom which can be got in this way. I find that a medium sized Cobra, that is one from 500 to 1,000 grammes weight, or ($\frac{3}{4}$ to $1\frac{1}{4}$ lbs.) will yield about 200 milligrammes of dried poison; the larger sized Cobras will give as much as 240 to 250 milligrammes.* The amount of water contained in the fresh liquid poison varies from 60 to 75%, so that fresh venom is a 25 to 40% solution of the dried material.

Let us say that a Cobra gives 200 milligrammes of dried venom. This is sufficient to kill 5,000 ordinary rats. It is, of course, without actual experiment, impossible to say how much Cobra venom it takes to kill a man, but calculating this amount on the basis that man is as susceptible weight for weight as a rat, and from my experiments on mice, rats, rabbits, monkeys and horses, I have no reason to believe that he is less susceptible, then 200 milligrammes of poison, the amount which can easily be got from a Cobra, would be sufficient to kill eight ordinary sized men, that is to say, that a medium sized Cobra can inject eight times the quantity which would be sufficient to kill a man. A large Cobra would have ten times the necessary amount.

Physical and Chemical properties of Venom.

Fresh liquid poison is of a yellowish or straw colour. Cobra venom is quite clear while Daboia poison has, as a rule, a small quantity of undissolved suspended matter. The reaction of both venoms is invariably acid to litmus paper unless there has been much admixture with the alkaline secretions of the mouth. Cobra venom has a very bitter taste: shewing Daboia venom is like chewing ordinary gum acacia—there is no taste at all.

Venom dried rapidly in a thin layer over calcium chloride cracks into small pieces. In the case of Cobra poison these particles are of an irregular shape, as broad as they are long; they are yellowish and translucent. In the case of Daboia venom the cracking is more or less in longtitudinal

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NOTE.—1 milligramme = ·015 grain or about $\frac{1}{65}$ part of a grain.

striæ and in consequence fine needle shaped particles are found. I show you here good specimens of both these varieties.

Thoroughly dried venoms retain their toxic power for an indefinite period. They dissolve again readily and completely in water or salt solution.

It is quite unnecessary for me to enter into the complicated question of the chemical composition of these poisons. At one time, not very long ago, it was thought that the toxic constituents of all snake venoms were alkaloids, similar to the poisonous vegetable alkaloids such as Strychnine. This however has been shown to be an entirely erroneous supposition, and I think I am right in saying that all investigators are agreed that all snake venoms owe their poisonous properties to the proteid or albuminous substances which they contain in solution, substances similar in composition to the albumen or white of egg. All snake poisons are in fact almost pure solutions of proteids and contain little else beyond a trace of inorganic salts, and a small quantity of an organic acid and colouring matter. Further, there is no doubt that each venom contains two or more different proteids and that the physiological action of a particular venom depends on the nature of the proteids which it contains. Organic chemistry has unfortunately not advanced far enough as to be able to separate in pure form these various proteids or to arrive at any estimate of their chemical composition. We have therefore to content ourselves at present with various crude methods of studying the physiological actions of the different proteids in snake venoms.

Effect of heating Snake Poison.

When a solution of snake venom is heated the poison is affected in two ways :—

1—Some of the proteids present become coagulated in the same way as the albumen of egg is coagulated for breakfast.

2—The toxic power of the proteids which are not coagulated is impaired while their solubilities are not altered.

Whether the toxic power is completely destroyed by heating or not depends on the degree of heat used, the duration of time for which it is

applied, and the strength of the solution which is heated. Different poisons are affected in different ways. Thus while a 0·1 % solution of Cobra venom can be heated for half an hour at 73°C with the result of only slightly diminishing its original toxicity, heating a 0·1% of Daboia venom at the same temperature for the same length of time completely destroys its toxic power so that large quantities can now be introduced into the blood stream of an animal without causing any symptoms.

You will appreciate from this, then, that we have arrived at the stage when we can say that the poison secreted by a Cobra is in all probability of quite a different nature from the venom manufactured by a Daboia. In this connection I may say, without entering into tedious details and long explanation, that I feel to-day in a position to state, without fear of contradiction, that Cobra venom contains no poisonous element, with perhaps one exception, which is contained in Daboia venom and *vice versâ*, that Daboia venom is necessarily quite free from any of the toxic constituents of Cobra poison. I know that this opinion is in contradiction to the working hypothesis put forward by Martin of Melbourne some years ago—an hypothesis which however was only provisional and fitted to the facts then available.

Physiological action of Venoms.

We have therefore now to pass on to a brief consideration of the manner in which each of these venoms brings about its fatal result when injected into an animal.

Let us begin with Cobra venom, the poison which has received more attention from investigators than any other. If one injects a solution of Cobra venom into a hot-blooded animal, no matter what the species of the animal may be, one observes a train of symptoms which there is no doubt points to the poison having acted directly on the central nervous system, that is the spinal cord and brain. The animal after a while becomes lethargic and disinclined to move—there is no preliminary stage of excitement : then one observes that the hind legs have become paralysed, the animal drawing them after it when endeavouring to progress. The paralysis of the hind legs gradually becomes more marked while at the same time it spreads forwards and involves the fore legs. Ultimately the animal becomes completely

paralysed and lies down, unable to move. The breathing still continues. Thus one sees in all such experiments a most striking and typical picture—the animal, be it bird or mammal, mouse or horse, lying on the ground completely unable to stir, the breathing still going on, and the saliva trickling from its mouth.

This however does not last long. The paralysis soon involves the respiratory centres : gasping in the search for air becomes marked and the scene is closed with the total cessation of respiration. Just before this however there may be slight general convulsive movements due to the accumulation of carbonic acid gas in the system. Mark you, there has been no word of failure of the heart, there has been no diminution in the strength of the pulse. After the breathing has completely stopped, if one opens the chest, one sees the heart beating away as if nothing had happened. I have observed this beating go on for twenty minutes to half an hour after the chest has been laid open and gradually to become weaker and weaker, and ultimately cease altogether.

As well as this action on the central nervous system Cobra venom has got an action on the blood. It has got a very wonderful power of breaking up the red corpuscles of the blood with the result that a certain amount of the colouring matter is set free. Thus when a sample of the blood is taken in a test tube after death and allowed to clot, the serum is noticed to be dark red in colour due to the hæmoglobin which has been set free. Further, it has an action on the normal coagulability of the blood—that is to say, on the property which blood has of coagulating or setting when withdrawn from the vessels. The clot which forms is not so firm or so compact as in normal blood and the time which it takes to form is much lengthened. As far however as my experiments have shown me, I cannot find any possible relation between the nervous symptoms which I have described and this action which Cobra poison has on the blood. This conclusion is, I know, contrary to the opinion of Cunningham, who however is the only observer who contends that the action on the blood is the primary one and that the nervous symptoms are dependent on, and result from, this destruction of the blood cells. This is a long and complicated story and one which I hardly think would give us much profit to pursue at this time.

If Cobra venom be injected directly into the blood stream—into a vein for example—the same train of symptoms as I have described is observed, the only difference being that the symptoms come on more quickly and march to a fatal termination much more rapidly than when the injection is given under the skin.

When a man is bitten by a Cobra, the same general symptoms which I have sketched above as following the artificial injection of the poison into an animal are observed. As well there is, as a rule, at the beginning, sickness and vomiting and a feeling of lethargy and disinclination to work: paralysis however soon sets in, and life ends, as we have seen, by cessation of respiration.

In addition to these general symptoms however there are marked signs of poisoning locally at the site of the bite. There is very severe pain which follows immediately on the infliction of the wound. The parts around become swollen and tender and a bloody plasma oozes away from the punctures. If the bite has been inflicted on a dependent part such as a finger, the swelling spreads up the digit which soon becomes exceedingly tense and extremely painful. Should the patient ultimately recover from the general condition the tissues for a short distance around the bite die, a black slough forms, and on separating leaves a deep hole. This hole heals up very slowly and there is left an ugly depressed scar.

To complete the picture, I may state that in man the general symptoms as a rule do not set in for an hour or two after the bite, and that on the average death takes place about six hours later. The fatal result however may be accelerated or, on the other hand, it may be delayed for some considerable time, even a day or two, according to the amount of poison which has been injected. You will appreciate nevertheless that we have got in all cases a certain interval of time, as a rule some hours, between the bite and the onset of symptoms and death, an interval of time, precious indeed as you will see, when I come to speak of the treatment of these cases.

Such then is a short sketch of Cobra intoxication. We may now pass on to the consideration of the effects of an injection of the venom of Russell's Viper or Daboia. Experiments with this poison and clinical

observations on actual cases show quite a different picture to what I have described in the case of Cobra venom. I have had the privilege of studying the action of Daboia poison on many varieties of animals—mice, rats, fowls, pigeons, guinea-pigs, rabbits, monkeys, dogs and horses. At the outset it would be well to clear the ground by stating that as far as my experience goes, it would appear that Daboia venom has no direct action on the central nervous system. I have never seen paralysis of the legs, even in the prolonged cases, follow its injection. The respiration is only interfered with as a result of its action on the blood and heart. Its action seems to be confined entirely to the circulatory system, *viz.* the blood plasma, that is the fluid part of the blood, the blood corpuscles, the capillary walls and the heart.

We may divide all cases of Daboia intoxication, into two groups—(1) those cases in which death follows very rapidly—say within 10 or 15 minutes, or sometimes it is only a few seconds—after the injection, and (2) those cases in which death is prolonged for some hours or even some days after the injection.

Let us take the first group.

When a small quantity of Daboia venom is injected directly into the blood stream of an animal—say, into the marginal vein of the ear of a rabbit—or when a large quantity is put under the skin, say of a pigeon, death follows rapidly—sometimes in a few seconds, sometimes after a few minutes. You will notice that the animal first becomes unsteady on its legs, its powers of equilibration are seriously affected; then it falls down and almost immediately violent general convulsions set in. Death follows in a few seconds after the onset of these convulsions. From the observation of these symptoms Cunningham was led to believe that they resulted from the direct action which the poison had on the central nervous system. This however I have shown to be quite an erroneous hypothesis. What then has really taken place ? On opening the animal immediately after death if the dose has been at all a large one, the whole of the blood is found to be clotted solid; the cavities of the heart, the veins of the lungs and abdomen and even the arteries are found full of solid clot. The heart has of course ceased to beat. If the dose has been a smaller one the clotting may be confined to the pulmonary veins, the right heart and the portal veins. The degree

and extent of the clotting depend on the amount of venom injected and the rapidity with which it has been injected. But in all cases of rapid death resulting from Daboia intoxication there can be no shadow of doubt but that the fatal result has been caused by this most extraordinary and remarkable intravascular clotting. The symptoms which Cunningham interpreted as resulting from a direct action of the poison on the central nervous system are due to carbonic acid poisoning, the result of the non-æration of the blood in the lungs.

In the second group of cases in which death is delayed for sometime we have several different phenomena presenting themselves.

In the first place death may follow in a few hours after the injection. In such a case the fatal result is, I am sure, due to the depressing action which the poison has on the heart. Thus I have seen a horse, which has received into a vein a quantity not sufficient to cause clotting, fall down quite collapsed : its pulse has become feeble, hardly to be felt : its body cold and covered with perspiration—a typical picture of cardiac depression or syncope, known popularly as a faint. There was no paralysis : after a rest the animal got up and walked about only however to fall down again in another faint. This condition sometimes ends in death while on the other hand it may be recovered from.

In the second place, should the fainting condition be recovered from, then a whole series of phenomena develops which is dependent on the action of the venom on the blood corpuscles, the coagulability of the blood, and the capillary walls.

I have told you that when large doses are given either intravenously or subcutaneously, the coagulability of the blood may become so increased as to lead to rapid intravascular clotting and death. Should however the quantity be not sufficient to cause this, and especially will this be the case if the subcutaneous method of injection has been used, then the very opposite condition of blood coagulability results. In some cases the blood remains absolutely unclotted when drawn into a test tube, while in others it clots only after a long interval of time and the clot is very loose and soft. As well as this action on the coagulability of the blood Daboia venom, somewhat similar to Cobra venom, has a very marked destructive effect on the red blood corpuscles.

Further, Daboia venom has a great destructive action on the capillary walls making them more permeable to the blood they contain—a blood by its deficiency in coagulability more ready to exude out. As a result of these various effects on the blood and capillary walls it comes about that bleeding is very common in these chronic cases of Daboia poisoning. Thus around the site of the actual punctures, or injection in experimental cases, there is a large bloody extravasation and much swelling. This swelling spreads rapidly up the limb. The tissues all around die and offer a suitable pabulum for all sorts of bacteria. Thus it happens that death in these cases usually results from some bacterial poisoning such as malignant œdema, or general septicaemia. As well as this local action hæmorrhage may take place from every orifice of the body,—from the nose, from the mouth, from the bowel or from the kidney and bladder. The blood is in a fluid condition and clots badly, while the destruction of the small vessel walls allows it to exude easily. The blood stained fluid which exudes contains few red corpuscles : the colouring matter of these has been dissolved out and now stains the plasma.

Such then is the picture of a typical case either actual or experimental of chronic Daboia intoxication, and it is this state which is usually seen to follow the bite of a Daboia in the human subject.

This condition can be and often is recovered from, the great danger being, as I have indicated, a secondary bacterial infection.

Thus while I have said that a man bitten by a fresh medium sized Cobra, if the snake succeeds in injecting even a modicum of its poison, will invariably die if left untreated, it often happens that authentic cases of bites from the Daboia recover, even after serious hæmorrhages have occurred from many places. As I have said I have never seen paralysis in all my experiments with Daboia venom nor can I find any authentic record of such having occurred in actual cases. To sum up then it would appear that Daboia poison acts mainly if not entirely on the circulatory apparatus.

(1) It affects the coagulability of the blood : injected directly into the blood stream or in large doses under the skin it so increases this as to cause extensive intravascular clotting. In small

doses it causes, after no doubt a short lived phase of increased coagulability, a marked and prolonged phase of diminished coagulability, so that in some instances I have noticed the shed blood remain absolutely unclotted even after 24 hours.

(2) It has a destructive action on the red blood cells, breaking these up and setting free the colouring matter contained in them.

(3) It has a marked destructive action on the capillary walls rendering them more permeable to their fluid contents.

(4) It has a marked depressing action on the heart, so marked indeed as to sometimes lead to a fatal termination from this action alone.

(5) It has no action on the central nervous system, and there is therefore no paralysis ever observed.

Such then, as far as I know it, is the physiological action of the venom of the Daboia Russellii.

As regards the Bungarus or Krait family I have had little or no experience. From a few experiments recently made with the poison of Bungarus Fasciatus it would appear that in large doses it has the property of causing intravascular clotting while in smaller doses it causes paralytic symptoms similar to, but more prolonged than, those resulting from Cobra venom. Beyond this I cannot go for want of material. I should earnestly appeal therefore to you, Gentlemen, to send me if possible many Kraits especially those of large size. I have received several snakes marked 'Kraits' but unfortunately only two of them have turned out to be of this family and these two have now joined the majority of victims of good treatment and over feeding.

With the poison of the Echis Carinata I have made no experiments whatever.

The treatment of cases of Snake bite.

In conclusion I have a few words to say as regards the treatment of cases of snake bite. When we consider the terribly dramatic, even tragic, circumstances attending these cases it is not to be wondered at

that the treatment of cases of snake bite has been surrounded by all kinds of quackery and roguery, especially in a country like India where the people's emotional reflexes are easily stimulated to belief. Who has not heard of the method, still in vogue, of applying the cloacæ of fowls to the bite, one after the other : the fowls mysteriously die almost as soon as the application is made, until there is arrived a time when the poison has all been "sucked out" and the fowls no longer die : who has not heard of the magic stone, of the virtue of nem leaves, both when locally applied and when internally administered, of spells and incantations. What remedy has not been tried and vaunted as a specific for these cases. Strychnine, Alcohol, pushed to cause helpless drunkenness, &c. have all at various times been praised and put forward as absolutely infallible. All these methods and drugs and many others besides have had however to give way before the test of scientific research. While however scientists have so ruthlessly demolished all these so-called specifics, they have given us a remedy, certain and trustworthy, for at least all cases of Cobra bite. I speak, Gentlemen, of the anti-venomous serum prepared by Dr. Calmette of Lille, which can be procured and easily used by any one. I have carefully guarded myself by saying that this serum is useful at least for all cases of Cobra bite, for, while Martin of Melbourne has shown that it has little or no power to neutralise the poisons of the two poisonous Australian snakes, *viz.* Pseudechis and the dreaded Hoplocephalus, I have demonstrated in many experiments with different animals that it is of no avail whatever in counteracting the poisonous effects of Daboia venom. I have not yet tested it with the venoms of the Krait family or with that of the Echis but from *â priori* reasons it is almost certain that it would have no power whatever to neutralise either of these poisons. But it is a great step in advance that we have at hand an antidote to the venom of the Cobra, certain and infallible if properly administered. If such is possible to obtain, then we have hopes, amounting almost to certainty, that anti-toxic sera will ultimately be obtained for the poisons of our other snakes. Such then is the position of the question at the present day as far as our Indian snakes are concerned. I am quite aware that Calmette claims that his serum is equally effective against any kind of snake venom. But Martin, Cunningham, Stephens, Hanna and myself have shown beyond a doubt that this statement is an untrue one and must be considerably modified. As regards the reasons for this opinion, both *â priori* and experimental, it is unnecessary for

me to enter into any polemical discussion. I have already done that elsewhere.

What then is this serum ? and how and in what doses is it to be administered ?

You are no doubt aware that animals react to the injection of some toxins or poisons, if the dose is not a fatal one, by manufacturing in their body an anti-toxin, that is to say, a substance which is chemically antagonistic to the toxin and which, by combining with the toxin in some obscure way or other, forms a substance which is no longer poisonous. This action is as far as we know quite specific. Thus the anti-toxin got by injecting an animal with a toxin called A, will neutralise that toxin A and not toxin B, no matter how closely allied these two toxins may be to one another. Further, there are only some poisons to which animals react in this way. Among these may be mentioned the poisons manufactured by the diptheria and tetanus bacilli, the vegetable poison abrin, and the venom of the Cobra and other snakes.

The method then of preparing an anti-toxin is to inject an animal with a small non-fatal dose of the toxin to which an antidote is desired. Some small amount of anti-toxin is then prepared by the animal. This enables the animal to stand a larger dose of toxin the next time. In this way by gradually increasing the dose of the poison at each injection and by allowing a sufficient interval of time between each injection for the formation of more anti-toxin, the animal becomes immunised, that is to say, becomes able to stand enormous doses of the toxin, each of which doses would represent many times a single fatal dose for an untreated animal. To get an animal up to this state of immunity requires a long time, six months to a year and in some cases even longer. Calmette takes 18 months to 2 years to immunise his horses. No one knows how and where the antidote is manufactured. But what is important is that this antidote is present in considerable quantity in the circulating blood. All that has to be done then is to tap the animal and collect the blood. The blood is allowed to clot and the clear fluid or serum which exudes from the clot contains the anti-toxin desired.

Horses being large animals and yielding a large quantity of blood at one time without damage to themselves are as a rule the beasts employed for this purpose. You will perhaps be astonished when I tell you that a horse can be bled to the extent of a gallon or more without doing it the slightest injury.

If you have followed me in this rather technical explanation you will now understand that anti-venomous serum is the serum of a horse which has been immunised with snake venom, that is, a horse which has been treated over a length of time with gradually increasing doses of venom. The serum thus got is put up into small bottles containing 10 cubic centimetres each. *

What then is the method of administration of this antidote, and in what doses should it be given ?

In the first place it is necessary for you to understand—and if you have followed me so far you will understand—that to be of any good whatever the anti-venomous serum must come into actual contact with the venom. Now, after a man is bitten by a snake the poison is rapidly absorbed from the site of the bite and circulates freely in the blood. Our aim therefore is to get the serum as quickly as possible into the blood stream, if possible before the poison has done any damage to the central nervous system, in other words before any symptoms have appeared.

This of course can be easily done by injecting the serum directly into a vein, such as a vein at the bend of the elbow. If competent medical assistance is at hand I should certainly advise all cases of Cobra bite being treated in this way. Less serum is required and the results would be more satisfactory. But unfortunately in these cases such assistance is not usually available. We have then to fall back on injecting the serum under the skin and allowing it to be absorbed into the blood from there, a process which Martin has shown occupies a considerable time. The best site for injection is I think the loose tissue of the flank. A large quantity can be injected there, if the needle is plunged deeply enough, without giving the patient the slightest inconvenience. If time permits the syringe should be boiled before being used but if symptoms have already developed this preliminary boiling may be dispensed with.

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*NOTE.—A cubic centimetre is about 16 to 18 drops.

As to the dose to be injected Calmette contends, on very slender, in fact on empirical, grounds, that from 10 to 20 cubic centimetres, that is from one to two bottles, is sufficient for any case of Cobra bite. In my opinion, and I speak from a large experimental experience with this poison as well as from some most interesting observations which I was privileged to make recently on an actual case of Cobra bite at the laboratory at Parel, this dose would in many cases fail to save the life of the patient. It is of course apparent to you that the dose of antidote necessary must depend on two unknown quantities, *viz.* (1) on the amount of venom injected by the snake, and (2) on the smallest quantity which can kill a man. It is also apparent that we must however always calculate on the assumptions that the snake has been a full sized one and that it has injected the maximum quantity which can be squeezed out from the glands and further that man is as susceptible, weight for weight, as the most susceptible animal with which we are experimentally acquainted. Granted these assumptions there is no doubt that from 30 to 40 cubic centimetres would be necessary in some cases of snake bite in order even to save the life of the patient. It is of course evident that in many cases, such as when the snake has been a small one, when it has already exhausted its poison, when it has not got properly home with its bite &c. a much smaller quantity would suffice. I should however recommend you to inject right off in all cases of Cobra bite three bottles of serum and to watch the result. If no symptoms appear nothing further need be done. Should symptoms come on after this injection another injection of the same amount should be given.

The above doses apply only in those cases in which marked nervous symptoms have not developed before the patient comes under treatment. Should paralysis have begun then intravenous injection should be made of at least 30 C. C., and if necessary repeated. The symptoms show us that the venom has already joined on to the nerve centres and to affect it now "mass action" must be resorted to. The poison must be separated from its connection with the nerve centres by means of an overwhelming amount of anti-toxin.

When the serum is used in this way and in these quantities I am convinced that if the patient is not absolutely moribund when he comes under treatment every case of Cobra bite should be saved.

Now a word in conclusion as regards the local treatment of these cases. Nothing should be done with the exception perhaps of applying a tight ligature above the bite. This delays the absorption of the poison, and gives the serum time to be absorbed into the blood and to neutralise the poison circulating there. Cutting open the wound, sucking, cauterising with the actual cautery or with strong acids and such like heroic measures are of little avail. They may destroy a small quantity of the poison with which they come in contact but in animal experiments it has been definitely shown that they do not or only slightly delay the march of the symptoms. In the cases where recovery has resulted after the use of these measures alone, the explanation undoubtedly is either that a fatal dose has not been injected or that the snake has been a non-poisonous one or perhaps a lizard.

The injection of chloride of lime at the site of the bite has been I know recommended by Calmette. Martin however has shown that this also has no effect in delaying the symptoms if a ligature has not also been applied. When a ligature has been applied along with such an injection it is the ligature and not the injection which has been beneficial. As regards the treatment of Daboia intoxication I know of no specific. These cases have to be treated on general principles—stimulants of a diffusible nature to tide over the stage of cardiac depression might be given. Beyond this I can suggest nothing which would be at all likely to influence these cases for the better.

In conclusion, Gentlemen, I should like to thank you for the snakes you have already sent us and to entreat you to remember that the whole problem of the action of the venoms of the Krait family and of the Echis has still to be worked out and that sera have still to be made for the poisons of the Daboia, the Krait and the Echis. I should ask you then to do your best to send me many of these snakes. There is no limit to the number I can receive. If you help me in this I promise you that I shall do my part of the work to the very best of my strength and ability.

SPEECH BY THE HON'BLE Mr. A. H. L. FRASER, C. S. I., CHIEF COMMISSIONER, CENTRAL PROVINCES, AT THE I. M. S. DINNER, MALARIA CONFERENCE, HELD AT NAGPUR ON 4TH JANUARY 1902.

Colonel Scott Reid and Gentlemen.—The high honour has been bestowed on me of proposing the toast of the evening, that we should drink to the Indian Medical Service. Before proceeding to discharge this duty, will you allow me to say one word of a personal character ? I have not only to thank our hosts for the pleasure which they have given me, in common with their other guests, in inviting us to be present with them this evening. I have also specially to thank them for this, that, when they found that I could not possibly avoid leaving Nagpur to-morrow morning, they altered the arrangements they had made, and fixed this dinner for this evening. I regard this as an act, not only of great courtesy, but also of great kindness.

Colonel Scott Reid, in proposing the health of the guests, remarked on the pleasure it gave him, amidst all the differences of opinion that prevail in this Medical Conference, to bring forward a proposition which would receive unanimous acceptance. I observed, however, that nine gentlemen did not drink to the toast he proposed. Three of these were members of the Conference, though not of the Indian Medical Service. The fact that they are guests here to-night prevented them from drinking to the toast. It is my privilege to propose a toast to which all may drink, whether hosts or guests. For surely the officers of the Indian Medical Service may drink, with as much enthusiasm as any of us, to the distinguished service to which they belong.

It is chiefly, however, as a layman and from the layman's point of view, that I must commend this toast to your acceptance. We owe a great deal to our Doctors. They get hold of us at times when it is possible for them to make a great impression on our hearts and minds, and to evoke, by their skill and kindliness, deep and lasting feelings of gratitude and esteem. We all of us know our times of weakness and disease. And, even to a strong man, it is a great satisfaction, when he feels that he is going under in the deep waters, to have a strong and kindly hand placed under his head to bear him up. No wonder then that our Doctors are among the best beloved of our friends. We may chaff at the profession sometimes, when, like Jeshurun, we wax fat and kick; but we know that we owe our Doctors the deepest gratitude.

Apart from this personal feeling towards the Medical profession, I owe the officers of the Indian Medical Service a great debt of official gratitude. I need not speak of the excellent work that they do for the Government and the public in the ordinary discharge of their duties, often under circumstances of great difficulty and discouragment. At the present time, after the years of calamity through which this province has passed, I look back with special pleasure to the services which Colonel Scott Reid and the officers serving under him have rendered to this province in respect of pestilence and famine. To our urgent call for help they responded with zeal and energy and self sacrifice which are beyond all praise, and with judgment and capacity which have secured our warmest admiration.

There is another obligation which we owe to the officers of the Indian Medical Service to which I may be permitted to refer. I mean this, that they are the brightest and cheeriest members of our small stations. No man who has served in small stations, as I have, can fail to estimate very highly this obligation. I fear that these officers can hardly be expected to take pleasure in the fact that their work has often to be done in very small and lonely stations. Let them at least be assured of this, that we realise what we owe them, and that we cannot do without them. My gallant and beneficent friend on my right—is not this the correct language in which to speak of a Major in the Indian Medical Service?—has informed me that this is the first occasion on which he has joined in drinking the health of His Majesty, the King-

Emperor. My friend works in a small station in another province, where they have no experience of such a festive gathering as the present. There are many such stations in this province. There is no very large station. There are only two or three that can be regarded as other than small. There are no prizes for the Indian Medical Service in this province. I wish that it were otherwise. All that I can say is, that all the more do I honour the men who discharge their duties loyally, efficiently and cheerfully in this province.

In this connection let me say that I sympathise with what has fallen from Dr. Stephens, one of the members of the Royal Society's Malaria Commission, in responding to the toast of the Guests. I share his regret that it is foreign, and not British, medical men who have been foremost in research, for example, in respect of cholera and plague. But I should like to say one word in defence of the Indian Medical Service in respect of the reproach that is sometimes cast on them in this connection. Let us picture to ourselves the life of the majority of the officers of that service in Civil employ in this country. The Civil Surgeon has to spend several of the best hours of the day in the District Jail, not in Medical work but chiefly in executive duty. He has to inspect work, write up interminable registers and returns, inflict punishments, keep accounts and haggle over the price of commodities with the local baniya. He comes from the hours spent in uncongenial work within these dismal walls, fagged and weary, to his dispensary. And there he too often finds the prejudices of the people an insurmountable barrier to any extensive practice of his profession. From that he returns home, with little energy left for scientific study or research. I have seen men—very exceptionally, I am glad to say—go utterly to the bad over this life. I have not wondered at their ruin, nearly so much as I have wondered at the strong and manly lives which the great majority of our Civil Surgeons lead under these adverse circumstances.

Despite all this, however, it cannot be denied that the Indian Medical Service has produced men of whom we have every reason to be proud : men like Major Ronald Ross, and, may I add, like our own Major Buchanan. These men have carried on their studies and inquiries, not in an atmosphere of scientific research, surrounded by laboratories and museums and Royal Societies, but isolated, solitary,

alone, with no one to prompt them, to guide them, to stimulate them, with no help and no inducement to effort. I regard such work as proof that the Indian Medical Service combines the old English pluck with the same high professional spirit as distinguishes their brethren at home. I trust that, now that the Government of India is taking up a more worthy attitude than formerly in respect of scientific research, great things are in store for the officers of the Indian Medical Service in regard to discovery and progress in connection with their profession.

May I be permitted to congratulate the Service on this Malaria Conference? I am very proud indeed that it is taking place in Nagpur. You heard yesterday afternoon of the important part which I have played in getting up this Conference. Coloned Scott Reid sang my praises in the matter in a way which called forth my blushes, despite the fact that in the kindly atmosphere of Nagpur I have become accustomed to such speeches. When I examine his statement, however, I find that my share in the matter consisted in having called on him for suggestions and then permitting him to carry them out. This is simple. It is an easy way of rendering public service. But, so long as I have so sound an adviser as Colonel Scott Reid, and an officer so capable of efficiently performing the duties entrusted to him, I am well content to adopt this line of action.

I must not, however, trespass longer on your time. Will you allow me to conclude with a reminiscence? I am a little of a hero-worshipper and, when last on furlough, I availed myself of an invitation to be present at the great McEwan Hall of the Edinburgh University, on the occasion of the presentation of the freedom of that ancient city to Lords Wolseley and Lister. Lord Wolseley first received this honour. The Lord Provost of the City recounted the great service which that gallant officer, then Commander-in-Chief, had rendered to his country. And you can fancy how cordially Lord Wolseley was received when he stepped forward, covered with medals and the insignia of many orders, to acknowledge the compliment that had been paid him. Then the Lord Provost tried to give some account of Lord Lister's services to humanity; and the enthusiasm with which the great Surgeon was received baffles my power of description. The old man rose, dressed wholly in plain black, with no ornament, with

his splendid head and strong but benevolent face; and, taking the casket respectfully from the Lord Provost, he placed it on the table and proceeded simply to return his thanks. He told us of his early connection with the Edinburgh School of Medicine and with Professor James Syme, of his practice in our City, and of the kindly memories of it that he carried to London. He showed how deeply he valued the honour which the City had now conferred upon him. But he added that, great as were the pride and pleasure with which he received that honour, they were as nothing compared to the satisfaction which he felt in believing that it was true that he had at least done something—the best he could—to alleviate human suffering. At this point the vast audience, almost exclusively composed of highly educated or exceptionally capable men, rose and cheered him vociferously. When silence was restored, Lord Lister added, "And this satisfaction and honour I share with the humblest member of the noble profession to which I belong."

I leave you, Gentlemen, to judge how that sentence was received. This is the ideal of the Medical man. This is the key-note of the profession to which the officers of the Indian Medical Service belong. I call on you, hosts as well as guests, to join with me in drinking to the prosperity and success of that Service—The Indian Medical Service!