SOME OBSERVATIONS ON MALARIA IN THE NORTHERN PROVINCE OF TANGANYIKA TERRITORY WITH SPECIAL REFERENCE TO IMMUNITY.

by


M.D., 1936.

X I am indebted to the Director of Medical Services, Tanganyika Territory for permission to present this Thesis.
The greater portion of Tanganyika Territory is low lying, hot, and malaria is endemic. In consequence of an immunity gained during childhood malaria, in the adult indigenous population of these areas, is seldom if ever an event of serious import and the illness is a transient one. The mere finding of a malaria parasite in the blood of a native child, over the age of two years, would not justify the assumption that the symptoms from which he suffered, and had brought him to hospital were caused by malaria. It must be remembered that an examination of a hundred of his playmates, who to all intents and purposes were suffering from no measurable disability, would be likely to reveal somewhere in the region of fifty to eighty positive blood slides and a similar number of enlarged spleens. As the age increases, so the tolerance to the malaria parasite increases. Daniels (1901) found that such was the case and also shewed that immunity could be measured taking the splenic index as the guide. Other workers in other parts of the world have amply confirmed Daniels' observations; the work of Gill (1914), Christopher (1924), Barber Clinger and Putman (1931), and Sarkar (1932) being amongst the more important in endemic regions; while the excellent report of the Malaria Unit Tanga for 1933-34 by Wilson (1936) has
special reference to Tanganyika Territory. In this report it is amply shewn that the dangerous age in African children is during the first twelve months of life and by the age of two years the stage of acute infestation is definitely waning. The process of acquired immunity/strains of various species has been shewn adequately by the work of Yorke and Macfie (1924), Nicol and Steel (1925), James (1926), and James (1931).

There are a few areas at high altitudes in Tanganyika Territory, with large populations where a very different picture is presented. There the native has no contact with malaria during his childhood or adult life and in consequence has no opportunity of acquiring an immunity. What follows is an attempt to demonstrate how serious an affair an attack of malaria can be to these non-immunes who so often are classed together, in their reactions to malaria, for no better reason, it would appear, than the similarity of the colour of their skins.

As a typical example of such an area there can be none better than the Chaga country on the slopes of Mount Kilimanjaro which lies across the third degree of south latitude. There are about 160,000 of this intelligent and progressive tribe who inhabit the mountain and live almost exclusively from 3,500 ft. to about 6,000 ft., where the forest reserve commences. The base of Kilimanjaro is about 40 miles
in diameter and the surrounding country is lowlying so that it can be seen with the rapid rise to its summit (19, 200 ft.) that the Chaga population are at no great distance from country where there is abundant malaria.

Moshi town, which is the Administrative and Medical headquarters of the District is situated at an altitude of 2,650 ft. to the south of the mountain, at the terminus of the Tanga-Moshi and Voi-Moshi Railways. The native population of the town is largely made up of foreign tribes, from hyperendemic areas, but Chaga from the less fertile regions of the mountain particularly Urombo, on the east side of the mountain, occasionally settle on the region closely surrounding the North of the town where the soil is excellent and springs abound. Others seek work from time to time on European farms lying east of the town. These areas will later be shewn to be malarious and the Chaga who come to work in these areas are particularly interesting in their reactions to malaria.

Medical men who have worked constantly in areas where malaria is endemic seldom see pernicious symptoms of malaria in adult natives, such as cerebral malaria and blackwater fever. It is proposed therefore first to describe some cases of Blackwater Fever met with in natives, selected as they illustrate various interesting conditions of life.
BLACKWATER FEVER CASES.

1. Elidi binti Nakara.
   Tribe - Chaga
   Age - 35 years
   Residence - Rau (on outskirts of Moshi - 2,650 ft.) for 1½ years.
   Previously, since birth, Mamba (on Kilimanjaro 5000 ft.)

   She gave a history of no fever until coming to Rau where she had frequent attacks of fever.
   She was attended at hospital on the 12th May 1932, her blood slide shewed a heavy infection of Subtertian parasites. She was given quinine 10 grs. at 2 p.m. that day and a similar dose at 7 a.m. on the 13th May. She passed Blackwater at 11 a.m. and was admitted to hospital with a typical severe attack of Blackwater Fever. She recovered.

2. Ismail Amnos
   Tribe - Chaga
   Age - 12 years
   Residence - Old Moshi since birth (about 4000 ft.). This boy had been attending the school at Old Moshi for 5 years and gave a history of having for the past two years paid frequent visits to Rau (2,650 ft.) with his father to visit friends. On these visits he frequently remained overnight at Rau. Until he made these
excursions he had not suffered from fever, as far as his relations were aware, but during the last two years he had frequent attacks which had been treated by the Dresser connected with the school. The treatment appeared from his description to be intermittent and inadequate.

He had a sharper bout of fever than usual on the 9th April 1932 and was treated in the usual way with quinine at the school, but developed Blackwater Fever that evening and was admitted to hospital.

This patient recovered.


Tribe - Chaga

Age 22 years

This native had been a resident of Old Moshi (4000 ft.) since birth until 1929 when he obtained employment in the Public Works Department. His work was chiefly on roads particularly the Moshi-Arusha Road and during the three years previous to his admission to hospital he stated that he had had a considerable number of attacks of malaria. For the last few months before admission to hospital he had been working on the construction of the Magdirisho Bridge near Usa (Usa is a malarious area, East of Arusha on the Moshi-Arusha Road;
Wilson (1936) found 70.1% positive blood slides in that area in children ages 0 - 10 years.

He was admitted to hospital with Blackwater Fever on the 11th April 1932 and made an uneventful recovery with appropriate treatment. He had not had quinine for some days before the onset of the Blackwater.


Tribe - Chaga

Age - About 20 years

This native was born at Mashame (5000 ft.) and had resided there from birth until about 5 years before his admission to hospital on the 29th January 1932 when he had come to Moshi to search for employment. For these five years he was intermittently employed by a firm of motor mechanics in Moshi. Before coming to Moshi he had had no attacks of fever, but thereafter had frequently suffered. Most of these attacks had been treated with small quantities of quinine which he obtained at Moshi Hospital and Mashame Mission Hospital.

He had been residing in Moshi continuously during the year 1931, during which time he had six attacks of fever.

When he was admitted to hospital in January 1932 he was suffering from unmistakable attack of Blackwater Fever. The urine cleared
cleared 24 hours later and convalescence although slow was uninterrupted.

5. A local woman was admitted to hospital during the month of July 1932, suffering from severe malaria.

She had resided at Uru (4000 ft.) in Moshi District with her husband until June 1931; they had both been residents of that district from birth. In June, 1931, they were sent to Mwanza on Lake Victoria to assist in teaching at the Mission there; while in Mwanza, they had continuous fever culminating in the death of her husband in July 1932.

The Medical Officer, Mwanza, was written to for a note on this man's case and the following is an extract from his reply:

"Ernest Semali died of Blackwater Fever in this hospital on the 1st July 1932. He was admitted on the 28th June 1932 with fever, diarrhoea, and vomiting and his blood was full of malaria parasites; he developed Blackwater Fever on the afternoon of the day of admission and suppression of urine next day"

6. Grace Christopher

Tribe - Arusha-Chini

Age - 10 years

Had resided on the outskirts of Moshi Township all her life, first at Njoro (2,500 ft.) and later at Rau (2,500 ft.); these areas will
later be shewn to be hyperendemic areas.

She was admitted to hospital on the 13th July 1932, suffering from Blackwater Fever. She had had a temperature for three days previously, quinine was given at 9 a.m. on the day of her admission and she developed Blackwater at 12 noon that day, suppression of urine followed, and she died on the 16th of July.

The interesting factor in this case is the residence from birth in areas which were full of malaria where the average African child would have gained a definite tolerance for the malaria parasite by the age of ten years.

John Christopher, the father of the child, had been for many years connected with the Medical Department. He was Head Dresser at Moshi Hospital and subsequently Medical Attendant at Old Moshi School. He was in the habit of giving his children prophylactic quinine. Some months before this child developed Blackwater Fever he was retrenched from Government service and had found it difficult to obtain sufficient quantities of quinine for prophylactic use.

This would appear to be an excellent example of the futility and danger of interfering with the natural process of immunity in a native population, of fluctuating fortunes, in endemic regions.
7. Merera, No.5435, Warder, Prison Department.

Age - 25 years

Tribe - Safwa

Residence: Mbeya (5000 ft.) from birth until he was about 23 years old. When he was 23 years old he joined the police, since joining the police he had been stationed at the following places:

(a) Tukuyu (over 5000 ft.) 1½ months - No fever.

(b) Morogoro (1600 ft.) 7 months - One attack of fever.

(c) Lushoto (4590 ft.) 7 months - No fever.

(d) Moshi (2,650 ft.) 1 year - Frequent malaria.

He was seen at the Police Lines at Moshi on the 15th. September 1932, had his blood examined and was given quinine. His blood shewed a mixed infection of Plasmodium falciparum and P. malariae. He developed Blackwater Fever that evening and was admitted to hospital where he recovered after a severe attack.

8. Abedi Sabuni

Tribe - Pare

Age - 25 years

This native had lived at Usangi on the Pare Mountains from birth until 1930 when he came
to Moshi to work as a labourer on the Karanga Sisal Estate. This estate adjoins the Njoro area which will be shewn later to be a hyperendemic zone.

He had frequent attacks of fever during his stay on this estate and developed Blackwater on the 20th. December 1932 having been given 10 grs. of quinine the day previously and 5 grs. of quinine that morning. He recovered in hospital after a severe and debilitating attack.

The Compounder in charge of Usangi Hospital gave me the following figures for Usangi in July 1933 which would lead one to believe that there is little malaria amongst the local residents.

<table>
<thead>
<tr>
<th>Groups</th>
<th>No. Spleens Examined</th>
<th>No. Spleens Enlarged</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 months to 5 years</td>
<td>38</td>
<td>3 (one child from the Plains)</td>
</tr>
<tr>
<td>6 - 10 years</td>
<td>53</td>
<td>Nil</td>
</tr>
<tr>
<td>11 - 15 years</td>
<td>17</td>
<td>1</td>
</tr>
</tbody>
</table>

Comments.

In the above eight cases of Blackwater Fever, to avoid repetition, no attempt has been made to describe their symptoms as the Blackwater Syndrome is such a typical one. Stress has been laid on their previous residence in respect to their contact with malaria parasites and where information was available mention has been made of quinine taken previous to the onset of the Blackwater.
The first four cases are similar in their history and serve to illustrate the effect of malaria in the Chaga residents of Kilimanjaro when they are exposed to malaria after having passed their childhood in the higher residential areas on Mount Kilimanjaro.

The fifth case is similar but it would appear that the malaria was contracted in Mwanza, a considerable distance from Moshi.

The sixth case is an excellent example of the effect of prophylactic quinine in preventing the establishment of tolerance to the malaria parasite.

The seventh and eighth are examples of Blackwater in natives of other tribes who have the one factor in common with the Chaga i.e. that they are normally residents of high altitudes and have spent their childhood in these areas. They shew that the lack of acquired tolerance to the malaria parasite is the chief factor at work in the production of the Blackwater Fever in Natives of Tanganyika Territory and that there would appear to be no predisposition to Blackwater Fever in the Chaga as compared with any other tribe.

The fact that many practitioners of medicine in this country have not seen a case of Blackwater Fever in a native is sufficient reason
for recording these cases and the extract from a report by C. H. Brennan (1934), which follows, amply reflects the usual experience of practitioners in endemic areas. The case described was that of a case of Blackwater Fever in a native child in Kenya Colony, no details were given with regard to residence in relation to malaria.

"I feel this case is worthy of notice as it is the first case of Blackwater Fever in what can be considered an unsophisticated African Native that I have ever seen"

The cases of Blackwater Fever described above did not appear to differ in severity from those I had seen previously in Europeans or Indians in this country. It is well known of course that the mortality in Blackwater Fever varies tremendously in different areas in the country and also from time to time in the same area. The reason for this is not quite clear.
1. **Ndewonasia.**

**Tribe - Chaga**

**Age - 50 years**

This man, who was a native of Mweka (5000 ft.) on Kilimanjaro (where he had resided exclusively since birth) came to hospital during the month of May 1932 suffering from a superficial head injury and was discharged from hospital absolutely fit. He returned to his home and a fortnight later had a severe attack of "fever" from which he recovered.

He had to return to Moshi early in July to attend the High Court Sessions which were being held there. He attended Court on the morning of the sixth July, although he had not been feeling well for some time, and that evening was brought to hospital in a comatose condition. His blood was full of Subtertian parasites, many corpuscles shewing double and triple infections while some corpuscles contained four parasites.

He died, despite of the most energetic treatment with quinine by intramuscular injection, on the 8th July at 2 a.m.
2. Mkashauri Lemenga.

Tribe - Chaga
Age - 12 years.

This girl who had resided at Old Moshi (4000 ft.) since birth, was brought to hospital on the 19th March 1933 at 6 p.m. in an unconscious condition and a temperature of 101°F. Her blood shewed a very heavy infection of malaria parasites. She received intensive treatment with quinine by intramuscular injection and appeared to have improved a trifle on the morning of the 20th March. At noon her condition was much worse and she died at 3.45 p.m.

Blood taken a quarter of an hour before death shewed a heavy infection of Subtertian rings and some Schizonts which were about \( \frac{3}{4} \) the size of a red blood corpuscle having on an average twelve merazoites with the pigment collected in the centre. Many of the mononuclear cells were heavily pigmented and crenated "Brassy" corpuscles were frequent. Specimens taken at this time were sent to Colonel Greig of the Tropical Medicine Department at Edinburgh University from where the presence of the Subtertian Schizont was confirmed.
3. Victor Petri
Tribe - Mchaga
Age - 15 years
This boy was a resident of Uru, near the Mission (about 4,500 ft.) on Kilimanjaro. He was admitted to hospital on the 25th March 1933 at 10 a.m. with a history of fever which had been continuous since the 14th March. He had resided at Uru continuously since birth until the end of 1932, after that he had obtained employment in Moshi Town for 1½ months, then the Karanga Sisal Estate for one month, where he had contracted fever. There was absolutely no history of fever in childhood previously.

On admission his temperature was normal, he was jaundiced, he was unable to speak and all his limbs were in a state of flexion. His blood slide shewed a very heavy infection of P. falciparum with, in many cases, multiple infections of the corpuscles. He died despite of treatment on the 26th March at 4 p.m.

4. Ambrose Sela
Tribe - Mchaga
Age - 12 years
This boy had resided at Urombo (4,500 ft.) on the Eastern side of Kilimanjaro until about
one month previous to his admission to hospital. During that month he was employed on a maize farm at Kinde, which is an area just North of the Arusha-Moshi Road, about 7 miles from Moshi, and is notorious for malaria.

He was admitted to Moshi Hospital on the 3rd. April 1933 with a temperature of 100°F; was mentally most confused and was unable to answer the simplest questions. He lay in an attitude of flexion. His spleen was not palpable. His blood slide shewed an extremely heavy infection of Subtertian parasites.

He recovered with quinine treatment and was discharged from hospital three weeks later.

On the 9th. of May he was re-admitted, this time unconscious, and again was found to have a very heavy infection of parasites, he recovered consciousness on the 10th May after intramuscular quinine treatment and his convalescence was normal.

5. Della Amma

Tribe - Mbulu

Age - 35 years.

Was admitted to hospital on the 18th April 1933 at 4 p.m. He was unconscious, temperature 99°F, liver and spleen were just palpable and his blood shewed an extremely heavy infection of Subtertian parasites. At 11 a.m. the following
morning he was still unconscious, the eye
reflexes were very sluggish, the blood now
shewed dividing forms of the Subtertian parasites.
He died at 2 a.m. on the 20th April.
A history was obtained from his relatives
who appeared at hospital some days later. He
was a native of Mbulu (over 5000 ft.) and had
lived all his life there until one month before
his admission to hospital when he was employed
by a Somali trader to take some cattle from
Mbulu to Moshi. The second day after leaving
Mbulu he slept at Mbugwe at the foot of the
Great Rift wall. Mbugwe is notorious for
malaria. He had been ill three days before
admission to hospital.

6. **Mengele Ngau**

**Tribe** - Chaga

**Age** - 25 years.

This man was admitted to hospital on the 19th
August. He was unconscious, temperature normal,
the liver and spleen were not palpable, and his
bladder was full up to the umbilicus.

His blood before giving quinine shewed a
very heavy infection of malaria parasites with
thickened rings, sporulating bodies were also
seen. Some of the mononuclears contained
pigment and one mononuclear was seen which
contained unmistakable red blood corpuscles,
infected with malaria parasites in the ring stage. One of these corpuscles was quite fresh, the malaria parasite in it shewed no sign of degeneration. The other corpuscle and its parasite were both partially degenerated. J. Gordon Thomson (1933) described several cases of phagocytosis of parasites by mononuclear and polymorphonuclear cells from Palestine, Kenya Colony, the Gold Coast and Borneo. Although the presence of pigmented leucocytes is, in my experience, of frequent occurrence in malarial films, this is the first time I have seen phagocytosis of red blood corpuscles, containing parasites, in a film of the peripheral blood. This case would appear to fit in with the suggestion made by H. Stott (1933) that phagocytosis is performed normally by the fixed reticulo-endothelial cells which are freed in the blood only in very severe infections.

This man slowly recovered; on the 23rd August he was able to answer simple questions, but had difficulty in articulating. On the 24th August he was much more intelligent and his articulation was considerably better. He was discharged ten days later.


Tribe - Chaga

Age - 14 years.
This child had lived at Marangu (4,600 ft.) since birth until 4 months previous to his admission to hospital when he had come to Moshi to seek employment. There was no history of fever before coming to Moshi.

He was admitted to hospital on the 12th June 1934, unconscious, temperature 99.6° and his blood was full of Subtertian parasites with multiple infections of the corpuscles. No sporulating bodies were seen. His spleen was not palpable.

He received 30 grs. of quinine intermuscularly during the first twenty four hours at the end of which he had recovered consciousness. His recovery was complete at the end of ten days when he was discharged.

8. Lulua Matefu.

Tribe - Chaga

Age - 16 years.

This boy had resided at Usseri, Urombo (5000 ft.) since birth till 1933 when he worked two months on a European Coffee Estate near Moshi. He then returned home and three months before admission to hospital came to Lower Uru (under 3000 ft.) near Moshi to work on a European farm there.

On the 16th of June 1934 he was admitted to hospital in an unconscious state. His temperature on admission was 102.4°F and his
spleen was just palpable.

1st. day received 20 grs. quinine by intramuscular injection.
2nd. day received 15 grs. quinine by intramuscular injection.
3rd. day received 10 grs. quinine by intramuscular injection.

Thereafter 21 grs. daily by the mouth.

He recovered consciousness on the 19th June, but was dull and confused for some days afterwards.

**Blood Examination.** 16th June shewed a double infection of *P. falciparum* and *P. ovale*. *P. falcinarum* not more than one in three of the parasites present, all young than typical ring forms, none of which shewed signs of thickening or commencing segmentation.

The remaining 2/3 rds. of the parasites present were *P. ovale*. All stages from young rings to early segmentation were present. All parasite cells but little enlarged, well marked fimbriation and a fair proportion of oval cells. No ganetocytes seen. Parasite count 1660 to 500 leucocytes.

D. Bagster Wilson and Margaret E. Wilson (1935) to whom the blood were sent reported this case. The following is an extract from their report:

"This was a mixed infection and was a good example of the difficulty of distinguishing young parasites, but we feel that the occurrence of cerebral symptoms in this non-immune African (it was probably his first infection) cannot be dissociated from what was undoubtedly the dominant infection, namely *P. ovale*"
The above eight cases of Cerebral malaria amply illustrate the reactions of non-immune Africans to malaria. The cases selected occurred in natives over the age of 12 years; at which age, in endemic zones, Africans have gained a definite tolerance to the malaria parasite.

Seven of the cases described were in Chaga residents of Kilimanjaro who had been infected on coming down to the plains to seek paid employment, and one was an Mbulu Native. There are 160,000 Chaga living on the slopes of Kilimanjaro and as there are already signs of congestion in that area the question of their future expansion is one in which the malaria problem must be kept in view by those in authority.

The Mbulu who number some 80,000 will probably not require to expand for some considerable time, but despite of the fact that only one cerebral case is referred to here, my experience on a previous tour, when stationed in Arusha, was that they suffered from malaria just as badly as the Chaga.

It is interesting to note that *P. ovale* was the dominant infection in the case Malala Matafu and the finding of ingested infected corpuscles in the case of Mengela Ngau is a sufficiently rare occurrence to be interesting. It might be noted that no quinine had been given in this case previous to the blood examination.
MALARIA SURVEYS OF AREAS PREVIOUSLY REFERRED TO

In order that the position with regard to malaria in the various areas would not appear to be a matter of conjecture only, the following are figures shewing spleen rates, and parasite rates, in some of the areas round Moshi, mentioned in relation to the cases previously described.

The areas surveyed were Kilema (4000 ft.), Uru (4000 ft.) Old Moshi (3,950 ft.), Mbokom (3,500 ft.), Njoro (2,650 ft.) and Msaranga (2,650 ft.)

The last two areas are examples of malarious areas surrounding Moshi township, while the others are typical examples of settled areas on the mountain; the great bulk of the population reside at altitude in excess of 3,500 ft.

KILEMA (4,800 ft.)

1. Number of children examined 100
2. Number of enlarged spleens Nil
3. Number shewing malaria parasites Nil.

URU (4000 ft.)

1. Number of children examined 100
2. Number of enlarged spleens 2 (one was in a congenital syphilitic)
3. Number shewing malaria parasites Nil.
OLDMOSHI (3,950 ft.)
1. Number of children examined: 105
2. Number of enlarged spleens: 1
3. Number showing malaria parasites: 3
   (P. falciparum)

MBOKOM (3,500 ft.)
1. Number of children examined: 100
2. Number of enlarged spleens: 14
3. Number showing malaria parasites: 14
4. Species of parasites:
   Plasmodium falciparum: 9
   Plasmodium vivax: 1
   Plasmodium malariae: 1
   Parasites not identified: 3

NJORO (on outskirts of Moshi Town) (2,650 ft.)
1. Number of children examined: 136
2. Percentage of spleens enlarged: 67.5%
3. Percentage showing malaria parasites: 72.2%
4. Species percentage to total number examined:
   P. falciparum: 61.7%
   P. vivax: 2.1%
   P. malariae: 1.4%
   P. falciparum: 40.7%
   P. vivax: 2.2%
   Parasites not identified: 3.4%

MSARANGA (on outskirts of Moshi Towns) (2,650 ft.)
1. Number of children examined: 96
2. Percentage of enlarged spleens: 86%
3. Percentage showing malaria parasites: 63.5%
4. Species percentage to total number examined:
   P. falciparum: 40.7%
   P. vivax: 7.3%
A subsequent examination of 149 children in the Njoro area in which the spleen was measured by Schüffner's method in the erect posture shewed the following figures for the age groups:

<table>
<thead>
<tr>
<th>Age</th>
<th>Spleen (Measurements were taken from the costal margin to the line drawn from the umbilicus to the anterior superior spine)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 2 years</td>
<td>2.9</td>
</tr>
<tr>
<td>2 - 6 years</td>
<td>1.9</td>
</tr>
<tr>
<td>6 - 12 years</td>
<td>1.5</td>
</tr>
</tbody>
</table>

**Methods.**

In the above survey only children from two years of age to 12 years of age were examined. The spleens were examined standing up and measurements were taken in fingerbreaths which was found to be a poor method of comparative measurement and in a further 149 children from 0 - 12 years were subsequently examined by Schüffner's method.

A thick blood and a thin blood were taken of each child on the same slide and after fixing the thin slide both were stained with Giemsa (1 drop to 1 c.c. distilled water)
This method admittedly does not enable one to differentiate parasites accurately particularly in those cases showing scanty ring infections. The difficulty occurs largely in the differentiation between *P. falciparum* and *P. malariae* in these cases. One was unable to make use of the Shute modification of the Leishman technic owing to difficulty in obtaining distilled water of the required pH value; this method would certainly have made differentiation easier.

About 20 minutes on an average was occupied by the examination of each slide and sometimes it was amazing how difficult it was to find parasites in the thin blood smear when a moderate infection had been seen in the thick one.

The thick blood smear was used entirely for the diagnosis of malaria and an examination of the thin slide followed in all positive cases to enable the species to be differentiated.
Summary.

1. The Chaga population living on Mount Kilimanjaro are living under conditions which gives them no opportunity of gaining a tolerance for the malaria parasite.

2. At altitudes over 3,500 ft. on Kilimanjaro there is extremely little malaria; below this level there is much malaria and at 2,500 ft. there is a spleen and parasite rate of about 70%.

3. *P. falciparum* is the predominant parasite met with but *P. vivax*, *P. malariae* and *P. ovale* are all present in this District.

4. Comparative methods of spleen measurement shew a decrease in the size of the spleen after the age period 0 - 2 years.

5. Four cases of Blackwater Fever in Chaga natives and three in other tribes from high altitudes have been described. These cases shew a mortality of 25%. Eight cases of Cerebral Malaria, seven in Chaga and one in a native of Mbulu have also been described; three of these cases died, the others recovered only as the result of energetic treatment.

6. It has been shewn that the adult Chaga is as prone to the pernicious type of malaria, including Blackwater Fever as is the unsalted European. This is not confined to Chaga and cases from other tribes, who have spent their childhood in malaria free areas, have been quoted.

7. Natives from endemic areas can be made liable to the more serious effects of malaria in later life if the acquisition of their tolerance is interfered with by prophylactic measures. (Blackwater Fever case No. 5)

8. Expansion of the Chaga, if they are to seek new land at lower levels, is fraught with serious danger from a medical point of view. It is inadvisable from the employer's and employee's point of view that natives, from the highlands of Kilimanjaro, should work in malarious areas unless adequate prophylaxis and treatment for malaria is easily available.

X None found in the surveys, but met with in the case of Lulua Matafu.
REFERENCES.


