NOTES ON MALARIA IN S.T. MALIeland

by

R. Choumara
Malarialogist of the World Health Organization

SUMMARY

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Geographical summary</td>
<td>3</td>
</tr>
<tr>
<td>1.1.1</td>
<td>The low coastal plain (GUEBAN)</td>
<td>3</td>
</tr>
<tr>
<td>1.1.2</td>
<td>The mountain chain (MOGO)</td>
<td>4</td>
</tr>
<tr>
<td>1.1.3</td>
<td>The HAUD plateau</td>
<td>4</td>
</tr>
<tr>
<td>1.1.4</td>
<td>Climate, rainfall</td>
<td>4</td>
</tr>
<tr>
<td>1.1.5</td>
<td>Hydrography</td>
<td>5</td>
</tr>
<tr>
<td>1.1.6</td>
<td>Potential larval breeding-places</td>
<td>5</td>
</tr>
<tr>
<td>1.2</td>
<td>Population</td>
<td>7</td>
</tr>
<tr>
<td>1.2.1</td>
<td>The family</td>
<td>7</td>
</tr>
<tr>
<td>1.2.2</td>
<td>Social structure</td>
<td>7</td>
</tr>
<tr>
<td>1.2.3</td>
<td>The habitation</td>
<td>8</td>
</tr>
<tr>
<td>1.3</td>
<td>Economic aspect</td>
<td>10</td>
</tr>
<tr>
<td>1.4</td>
<td>Level of education</td>
<td>11</td>
</tr>
<tr>
<td>1.5</td>
<td>Health education</td>
<td>12</td>
</tr>
<tr>
<td>1.6</td>
<td>Health services</td>
<td>13</td>
</tr>
<tr>
<td>2.</td>
<td>EPIDEMIOLOGICAL ASPECTS OF MALARIA</td>
<td>13</td>
</tr>
<tr>
<td>2.1</td>
<td>Historical</td>
<td>14</td>
</tr>
<tr>
<td>2.2</td>
<td>WHO survey</td>
<td>15</td>
</tr>
<tr>
<td>2.3</td>
<td>Methods of work</td>
<td>16</td>
</tr>
<tr>
<td>2.3.1</td>
<td>Malarithmetic data</td>
<td>16</td>
</tr>
<tr>
<td>2.3.2</td>
<td>Entomological data</td>
<td>18</td>
</tr>
<tr>
<td>2.3.3</td>
<td>Other investigations</td>
<td>19</td>
</tr>
</tbody>
</table>
3. OBSERVATIONS ........................................... 19
   3.1 Malarriometry ........................................ 19
   3.2 Entomological data .................................. 21
      3.2.1 A. gambiae ...................................... 22
         3.2.1.1 Morphology ................................ 22
         3.2.1.2 Distribution ................................ 22
         3.2.1.3 The anopheles ............................... 23
   3.3 pH of the water of larval breeding-places .......... 26

4. EPIDEMIOLOGICAL SUMMARY .............................. 26
   4.1 Discussion .......................................... 28

5. A FEW IMMEDIATE PROBLEMS .............................. 28
   5.1 Health education .................................... 28
   5.2 International political situation ................ 29
   5.3 Legislation .......................................... 29
   5.4 Antianopheline campaign ............................ 30
      5.4.1 Adult anopheles ............................... 30
      5.4.2 Larvae ......................................... 30
   5.5 Antiparasite campaign ............................... 30

6. CONCLUSIONS ........................................... 30

7. THANKS .................................................. 31
1. GENERAL CONSIDERATIONS

1.1 Geographical summary

Somaliland under British administration occupies an area of approximately 176,000 square kilometres (68,000 square miles) in the northern part of East Africa (the Horn of Africa).

Its land frontiers are formed as follows: in the west by French Somaliland for a distance of 72 kilometres (45 miles) and then by Ethiopia; to the south-west and south by Ethiopia: the Ethiopian frontier has a length of 800 kilometres (500 miles) and for nearly 650 kilometres (400 miles) runs in a straight line across an immense plateau which is very slightly undulating and offers no natural barrier. This is the HAUD, a place where population movements cannot be checked. To the east, the frontier is common with Somalia (the former Italian Somaliland, under United Nations trusteeship) for a distance of 435 kilometres (270 miles). The coast, comparable in length with the Ethiopian frontier, forms the greater part of the south of the gulf of Aden.

From north to south, there are three clearly defined natural zones.

1.1.1 The low coastal plain (GUBAN)

This disappears in places where the mountain chain runs right down to the sea (eastern region). Usually it is a few dozen kilometres wide and rises very gradually to a height of 500 metres (1500 feet) and then, continuing to rise to a height of about 1000 metres, it becomes more rugged in appearance and merges with the foot-hills of the mountain range.

In the lower part, which is sandy and over which large desert areas occur, the grass is poor; water is rare and malaria is usually absent (the most virulent focus discovered in Somaliland, however, is situated on the sea coast). Towards the first foot-hills of the mountain range, water points are more frequent and the vegetation is richer. This region is known to have a low rate of malaria endemicity.

---

1 These notes were compiled before the accession of the SOMALILAND PROTECTORATE to independence and its fusion with SOMALIA (1 July 1960) to form the SOMALI REPUBLIC.
1.1.2 Forming a continuation of the high Ethiopian plateau of HARAR and curving towards the east, parallel to the coast, there runs the backbone of the country, the mountain chain, or OGO, the height of which varies from 1000 to 2000 metres (3000 to 6000 feet). It is fairly steep on the northern side but the southern side drops more gradually down into a plateau which leads directly into the HAUD. It is here that the present capital, Hargeisa, is situated, together with a number of important centres.

Water points are fairly numerous here and the nomads fall back to them when the drought prevails over the HAUD pastures. Some points in this region have been considered as endemic and have been treated with insecticides but the main centres may be said to be practically free from malaria.

1.1.3 To the south of this mountain range and to the depth of several hundred kilometres, there extends the plateau of HAUD which merges into the Ethiopian Ogaden.

Almost all along the frontier mentioned above, marked by boundary posts, there are two parallel roads, one on each side of the agreed boundary. Only the one situated in Somaliland is actively used and it serves a number of more or less permanent villages set up in the two territories.

After the rains, this immense region, in which the subsoil water is at too great a depth for wells, provides excellent pastures which are shared - frequently not without friction - by hundreds of thousands of Somalis who come there from the various water points situated around its periphery both in Somaliland and also in Ethiopia and Somalia.

It is in the temporary pools and ponds of the Haud that A. gambiae finds an ideal breeding-place.

1.1.4 Climate, rainfall

In the main, the regions with the heaviest rainfall - 250 to 500 millimetres a year (10-20 inches) are situated above 1300 metres. They have rains more or less throughout the year, particularly in the interval between the "great" rains of April to June (GU) and the "little" rains of October to November (DHAIR), whereas the
regions that are situated lower dry up under the influence of the Khariff, a wind that is often violent and dusty and is due to the south-west monsoon. The coast sometimes has rain during the dry season (December-April) but there are also years when it is absolutely dry. The mountainous region of the west (round about Borama) is distinctly damper than the eastern region.

On the coast, the temperature varies from $21^\circ \text{C}$ to over $42^\circ \text{C}$ ($70^\circ-108^\circ \text{F}$). In the mountains there may be hoar frost and the maximum recorded is $37^\circ \text{C}$ ($99^\circ \text{F}$) with a difference between night and day temperatures that is often very marked (sometimes over $10^\circ \text{C}$). This fact, in conjunction with the habitual dryness of the area, accounts for the pleasant character of the climate, at all seasons, in the higher regions, whereas on the coast it is only the winter season, when the north-east monsoon - a sea breeze - blows, that offers any attraction.

1.1.5 Hydrography

It is possible to distinguish between:

- a basin on the north slope, running towards the Gulf of Aden;
- a basin on the east slope, which gives two quite distinct watercourses in Somaliland;
- the whole plateau (Haud), where a multitude of slight depressions (Balleh) which are normally dry but which have an impermeable bottom, collect and may retain for a month or more the surface water.

There is no permanent watercourse worthy of the name. After a rainfall the water pours in a torrent down the bed of the watercourse for a few hours or a few days but very rarely reaches the sea. Most frequently it dries up rapidly in the sands of the coastal region or the depressions of the Haud.

1.1.6 All the water points where animals and people drink are potential larval breeding-places. They may be summarily classified as WELLS, SPRINGS, TEMPORARY POOLS and CISTERNS.
(a) Wells and water-holes vary in depth from a few centimetres to 10 metres or more. They are dug

- either in the sandy bed of dried-up rivers; they then fill up naturally when the waters come;
- or on the banks of the river beds;
- or along the borders of the Haud, on the edge of the natural depressions and also in the gypseous soil of the Nogal (the north-eastern portion of the Haud);
- or in the sandy soil of the coastal region.

After some time, these wells are usually abandoned just as they are by their owner. So long as they are in use, few larvae are usually found there. But when they are abandoned - at all events in the case of those that are neither too deep nor too salty - they become dangerous breeding-places where there are frequently large numbers of *A. gambiae*.

The little natural cavities in which water remains more or less permanently, but with no outflow of running water, are called "water-holes".

(b) The springs usually appear in the dried-up course of a river bed, when the underground water filtering below meets a rocky sill which brings it to the surface. The volume of their flow varies greatly. Many of them are permanent but the water is lost in the sand after a course varying from a few metres to a few kilometres. Some are of fresh water; others are very saline. Some are free of all vegetation; others are invaded by algae and sometimes by weeds and reeds.

(c) The temporary pools or "balleh" are natural depressions which occur especially in the Haud. Some of them have been made into vast basins.

(d) The cisterns or "tanks" are, in a sense, only a particular case, on a smaller scale, of the reservoirs mentioned above; but the walls and the bottom are cemented so that water can remain there for long periods. Their average dimensions are 30 x 6 x 3.5 metres (90 x 18 x 10 feet), giving a capacity of more than 600 cubic metres (130 000 Imperial gallons). Long ditches drain into these cisterns to collect the water and these ditches lead first into a cemented sedimentation tank a tenth the size of the main tank into which it flows.
1.2 Population

No exact census has ever been taken, but it seems that the population based on the wells of Somaliland is in the neighbourhood of 650,000 and any figure between 500,000 and 1,000,000 might be reasonable.

Of Hamitic origin, 85 per cent. of the Somalis follow the hard life of nomadic shepherds. Their movements are determined by the search, in the first place, for good grazing and, in the second place, for water.

1.2.1 The Family

Although they are nearly all Moslems - frequently very strict - most of them have only one wife.

The fertility of the women seems to be high - and so is infant mortality, but no precise information can be given on the latter subject, except to say that it is only rarely due to malaria. In any one family, three to five living children is the rule. There are fairly frequently more.

The woman, kept in a strictly subordinate position - from which she is seeking more and more to free herself - is regarded as inferior (the blood-price of a woman is only 50 camels, which is one-half of the price of a male, even a male child). However provided the woman works actively, with her flock of goats and sheep and proves to be fertile, she exercises, by tradition, very great authority in her home circle and if she does not agree to an examination or a blood-test for the children - or to the disinsectization of her hut - the previous agreement of the husband will carry very little weight.

1.2.2 The social structure is essentially tribal. There are said to be some 360 clans (in which all males theoretically have equal rights) grouped in 12 tribes. At all levels, it seems that the "elders" have only a purely nominal authority over their descendants. On this almost anarchical traditional background modern institutions are being grafted little by little - there are municipal councils and a legislative assembly at work and ministers will shortly be appointed. But the Somali is ferociously individualistic - at all events the Somali of the "interior" in
contrast with the town-dweller - and seems to attach very little importance to these urban institutions. Nevertheless, with the help of the common language and the example of Somalia, a unifying national sentiment might perhaps be utilized for launching mass action - in this case, a malaria eradication campaign.

1.2.3. The habitation

The typical habitation is a portable hut or "aqal", made on a framework of from four to eight wooden hoops on which are fixed pieces of matting and skins. The whole structure takes the shape of an elliptical "cloche" which varies in height and in breadth according to its owner's resources or needs (they are expansible huts). There are no windows but a movable flap makes a door. These pieces of matting and skins partially overlap, of course, but they have no clearly determined respective positions and therefore are never found in the same situation in any two erections. Furthermore, this covering is more or less loose-fitting and there are often folds and recesses that are inaccessible to the most conscientious sprayman but where *A. gambiae* finds a perfectly safe shelter, even just after treatment with DDT. The average dimensions of these huts may be said to be: length 5 metres; breadth 3.50 metres; height 3 metres. There are larger ones with an internal division separating a working-space from the living-room, thereby giving a relatively comfortable arrangement. But there are miserable ones, especially in the west, made of tattered matting flapping in the wind, under which people and new-born sheep and goats all huddle together.

The furnishing is sketchy - some lengths of matting rolled up on the floor against the sides of the hut and unrolled for the night; a few trunks for clothing; containers in the form of jars for milk and water which, if they are empty, are hung from the hoops together with a few kitchen utensils and pieces of rope. It is very difficult to get the walls satisfactorily cleared (and if they are left to themselves the spraymen do not make a point of insisting on it) with the result that many more nooks and corners are left untreated together with those which are due to the actual construction of the habitation. Normally, these huts are by no means watertight. The rain water thoroughly soaks the matting which forms the roof and then collects in drops which little by little carry away all the insecticide deposit. It has been
observed that a few days after an aqal had been well sprayed there remained no trace of the work done except on a few vertical sections, on the hoops and on a metal plate horizontally embedded in the roof, the powdery whiteness of which stood out against the washed-out matting. Similar observations have been made on dozens of huts situated in different places. It was quite exceptional to find a deposit that was almost intact a few weeks after spraying and this occurred mostly in more substantial habitations over which the owner, being well off and anxious for comfort, had fixed a large square of tarpaulin.

Commonly, from two to five families who are related or friendly form a more or less temporary group for their migrations, their destination being kept secret from other groups. When they reach the chosen spot, the camels are unloaded and the women busy themselves with the erection of the huts whilst the men surround the little temporary village ("rer") thus created with a hedge of thorn branches ("zariba"), forming an enclosure for the animals so that they cannot wander off at night and are relatively protected from wild animals (chiefly lions, hyenas, panthers, jackals and foxes).

In addition to these "portable huts" there are semi-permanent constructions ("arish") of the same type as the rectangular African huts, with the difference that frequently, no daubing has been applied to the brushwood of which the walls are made, thereby giving an impression of something that is unfinished and abandoned and, at all events, making any residual spraying almost useless. Often the roof is just as rudimentary and also is of lattice.

It is true that, in some settlements and especially in the towns, there are real houses, frequently built of stone, of which the walls, whether plastered or not, would provide an excellent base for a film of insecticide. But, for many of these centres, there is no reason for disinsectization and where it would be very useful the conditions of the habitation are such that it could be regarded only as an auxiliary method or even rejected entirely (except in the case of a threatened epidemic).
1.3 Economic aspect

Apart from a few crops of a kind of millet in the BORAMA region and vegetable gardens in the neighbourhood of most of the main centres, the whole economic structure of the country may be said to be based on itinerant grazing. For this, in practice, it is necessary to be the owner of at least one or two pack-camels - or more accurately dromedaries - which carry on their backs the house and the other property of the family and go from the encampment to fetch supplies of water (sometimes several days' journey distant) for the people, the goats and the sheep. The last-mentioned animals have to be watered at least once a week, whereas, with good grazing, camels maintain themselves in excellent condition, without water, for more than a month. During this time, the herdsmen live almost exclusively on camel's milk, which is indeed excellent and, even in the centres of population, is a much sought-after food.

It is easy to understand the jealous care and affection the Somali shows for his dromedary, for on the latter depends his access to the Haud, that is to say, to fabulous pastures where the flock grows fat and multiplies, and also his return to the well. If the beasts of burden fail him at that time, it may mean not only his ruin through the loss of his thirsty flock but death for the Somali and his family in a Haud that can be completely waterless.

Anyone who flies over the country at the end of the dry season - or passes through it in any way whatsoever - is seized by an impression of immense desolation and finds it difficult to understand how these camels, sheep and goats that are seen "queueing up" at the rare water points, manage to subsist - and their owners also. Indeed, the situation is not a very bright one and if the drought is prolonged the livestock dies in hundreds, famine reigns and carries off its victims from amongst the human population as well.

Thus, for most of the time, the standard of living is very low though there is a small minority of rich landowners and wealthy merchants. These are, more particularly, the people who own the herds of cattle that scarcely ever leave the neighbourhood of the permanent water points.
During the last 10 years or so, two facts have progressively been changing the cycle of migrations and, as a result, the epidemiology of malaria in the country:

- the construction in the Haud of the cisterns or "tanks" described above (1.1.6 (d)). Every year some dozens of these are constructed. They represent for their owners both a guarantee of survival and an excellent piece of business. At the end of the dry season water is sold at from 8 to 20 shillings E. A. the barrel of 44 gallons (one and a half US cents a litre);

- the increase in the number of lorries which are used to convey water supplies to the points farthest from the permanent watering-places where the pasture, although dry, remains excellent and then, before going back at top speed to the wells, empty their load of water into the cisterns, with the result that some of these cisterns probably have not been dry for years (even at the end of the dry season in 1959 which was especially severe). It follows that a number of people who, when the pools are empty, would normally have had to fall back on their home well, are tending to settle in the Haud which is no longer a waterless region. It follows also that A. gambiae finds there conditions that are favourable for its reproduction all through the dry season and, when the first rains come, can then fly in swarms to the neighbouring pools.

"In this way, the danger for Somalia and Ethiopia is moving from the Shebeli basin, where the buildings of the sedentary classes are - or can be - effectively sprayed, to the immense, uncontrolled Haud. The malarial epidemiology of the whole of the Horn of Africa is being thereby radically changed" (Mario MAFII - personal communication).

1.4 Level of education

Only a very small proportion of children go to school. An intermediate school and a few primary schools which provide instruction in Arabic and in English have existed for several years. New schools are being opened. There are Koranic schools of a more or less temporary kind in most of the large villages and in the towns.
Some students are at present in Great Britain, Lebanon and elsewhere but very few qualified persons have returned to the country. There is a great shortage of staff both for secretarial work and for technical posts. Such work is almost always performed by Indians and Italians. This is a handicap which weighs heavily on any new activity, such as the antimalaria campaign, for all the "educated" staff are already otherwise employed, and usually there can be no question of detaching them.

1.5 Health education

Practically no attempt has been made to give intensive health education. It is true that there have been a few talks on the radio; from time to time a short note appears in the local newspaper; advice printed on leaflets in English and in Arabic will be widely disseminated, but the masses have scarcely been touched. (This seems to be true also of the antituberculosis campaign).

Owing to the extreme independence shown by the Somali, it might almost be said that he would have to be taken individually for any "indoctrination". For the moment, the Somalis have no idea of solidarity, of public welfare or of responsibility towards their fellows. They have no sense of community. It is easy to understand that, in such conditions, any action other than the actual treatment of the sick is looked upon with indifference, if not indeed with hostility.

Some slight success has been achieved in the treatment of the cisterns. There are some owners who have shown understanding and who are willing to make use of the antilarval briquettes that have been given to them. But, up to the present time, it has not yet been possible to appoint one person in each village who would be responsible for seeing that the Health Service recommendations are applied. If any particular owner has been convinced that using the briquettes is beneficial, that is all to the good. But if his neighbour is not so convinced - or is absent - no-one will take any action to put an end to the breeding of the mosquitoes.

A non-co-operative attitude encountered almost everywhere is expressed by replying to all arguments: "That doesn't concern us. That is the business of the government. Let the government do it, if it thinks it is good."
Obviously it is difficult to contemplate any eradication campaign in the absence of the almost complete co-operation of the population, especially in view of the nomadic conditions prevailing in the country. The present attitude will therefore have to be completely changed and there will have to be a better appreciation of what is in the interest both of the community and of the individual. This, of course, will be an enormous task to undertake. But it seems to be one of the major conditions for the success of the work. There may be some reason for thinking that a turning point in the political circumstances will perhaps make it possible to create favourable opportunities.

1.6 Health services

For administrative purposes, Somaliland is divided into six districts. The Health Service follows this pattern, with a hospital and health officers in the chief town of each district. Medical officers are responsible for everything in four of these centres and locally trained medical assistants in the other two. From 10 to 12 doctors are normally present in the territory (two of them being engaged on administrative work). The Deputy Director is responsible for health and the anti-malaria campaign. Fifteen small dispensaries are run, in the bush, by medical orderlies. It is planned to open two or three more of these on the frontier road.

2. EPIDEMIOLOGICAL CONSIDERATIONS

In general, the Somali people who are tall and well-built - the men are perhaps somewhat over-slim - seem to be remarkably healthy. Indeed, none of the main African tropical endemics, except malaria, is prevalent in the country (no trypanosomiasis, no yaws, no onchocercosis, no yellow fever, no schistosomiasis) nor creates any serious problem there (cerebrospinal meningitis, smallpox, recurrent fever, tropical ulcers). Trachoma seems to be more widespread than was thought (Dr H. Penkala - personal communication) but, the major disease is pulmonary tuberculosis which is becoming more widespread and against which a campaign has been undertaken, started in 1958.
2.1 **Historical**

For a very long time past - since well before the end of the last century, it is said - the Somalis have established the relationship between the bite of the mosquito and the appearance of the fever. Nowadays, they quite clearly understand the curative action of Kinin (quinine), as they call any antimalarial remedy.

It is somewhat difficult to trace the history of malaria very far back with any degree of accuracy but, in 1946, the Director of the Health Service wrote in his annual report: "The most important disease in Somaliland, as regards both morbidity and mortality, is malaria" and "briquettes" impregnated with heavy oil were already being placed in the cisterns.

In 1947, quinine was put on sale in the coffee shops which are the chief meeting places - where, incidentally, only tea is drunk.

In 1948, in centres where malaria was suspected of being endemic, the houses were sprayed with BHC and that treatment has been carried on more or less regularly up to the present time. From one year to another further settlements are added to the list and others are omitted from it.

In 1951, a serious epidemic was observed in the Haud. 7524 cases were recorded with a mortality of from one to two per cent. Prophylaxis with paludrine did not give very satisfactory results and the spraying of the portable huts ("aqals") was abandoned. GILLIES undertook his survey (1952), by means of which he added further information to that furnished by BAGSTER-WILSON in 1949, and of which, on the whole, the present observations constitute merely a development and confirmation.

Since that time, sporadic cases have been observed but there has been no evident epidemic. In 1956, for the first time, the Haud was systematically sprayed with dieldrin under a plan to cover the whole area.

In 1957 and 1958 the same action was taken on all accessible huts, but with DDT.
In 1959, only habitations, whether portable or not, in the neighbourhood of the cisterns were sprayed in May-June (a second cycle being planned for October-November) with, theoretically, two grams of technical DDT to the square metre (200 mg to the square foot).

It is interesting to consider the comments in the annual report of the medical services for 1957: "The reports received both from the dispensaries and from the itinerant medical orderlies give the impression that from 2000-3000 cases of clinical malaria were observed and treated. Allowing for the fact that this is only an approximation, there can be no doubt that there were many less cases of malaria this year than in 1951 when the prevailing conditions were similar - a season of abundant rain following on one of famine. The only figures showing the incidence with any degree of accuracy are those of the cases treated in hospitals. They are as follows:

<table>
<thead>
<tr>
<th>Number of cases of</th>
<th>1955</th>
<th>1956</th>
<th>1957</th>
<th>1958</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benign tertian</td>
<td>64</td>
<td>159</td>
<td>304</td>
<td>99</td>
</tr>
<tr>
<td>Malignant tertian</td>
<td>376</td>
<td>484</td>
<td>725</td>
<td>665</td>
</tr>
<tr>
<td>Clinical cases</td>
<td>713</td>
<td>759</td>
<td>807</td>
<td>975</td>
</tr>
<tr>
<td>Total</td>
<td>1153</td>
<td>1402</td>
<td>1836</td>
<td>1739</td>
</tr>
</tbody>
</table>

The "clinical cases" - which were not verified microscopically - come from the district hospitals where the staff employed part-time in the laboratory is insufficiently trained in distinguishing the different plasmodia..."

2.2 World Health Organization survey

For several years past, contacts and exchanges of correspondence had taken place between the Somaliland Government, on the one hand, and the United Nations Children's Fund (UNICEF) and WHO, on the other hand, with a view to setting up a programme for an antimalaria campaign, which was converted into a pre-eradication project. In April 1958, WHO sent out a malariologist who was followed in July of the same year by a laboratory technician.
According to the joint plan of action - government/UNICEF/WHO - the following were the AIMS of the survey, that is to say the mission entrusted to the little international team:

(1) The final aim will be to determine the methods that will make it possible to interrupt the transmission of malaria, so that, in conjunction with the neighbouring states and territories, an inter-territory programme of malaria eradication may be drawn up.

(2) The interim aims will be:

(a) to conduct a survey of malaria in the Protectorate as a supplement to the study of the endemic foci of the disease and, if conditions permit, to ascertain the mode of development of epidemics in the southern part of the Protectorate (Haud);

(b) to establish and execute an effective and economical pre-eradication project for the Protectorate with the overriding object of arriving at the interruption of transmission, which will include a study of the factors that might impede such interruption.

2.3 Methods of work

The first thing we did was to teach the staff placed at our disposal how to discover, collect, transport and preserve the larvae and adult anopheles correctly. It was possible later to train some of them for less elementary work and to let them take part in the work of staining and examination of blood slides and also in the identification of *A. gambiae* and the dissection of salivary glands and ovaries.

2.3.1 Malariometric data

It soon became obvious that very few of the investigations and periodical returns beloved of malariologists, such as were a matter of routine work for us, could be utilized in this territory - in particular, the random selection of a group of settlements in which there would be:
- every month, a blood test for all infants;
- every six months, an examination (blood and spleen) of a sufficient sample of children under 10 years and adults, and the bringing up to date of the demographic work.

The fact that there had been no census and that it was almost impossible to make a reliable one, the imperative need for an enquiry covering the whole of Somaliland and, above all, the extremely mobile character of the population, together with its lack of interest and its reluctance to agree to examinations, particularly if they were to be repeated (it is possible to take advantage of curiosity in the first place, but that very quickly wears off) - all this made any attempt at working "normally" quite hopeless.

All that was done therefore, when the opportunity arose, was to make occasional chance surveys and, with any given population which, in a given place, perhaps bore very little relation to the population that might have been examined in the same place a week earlier or a month later, we had to be content with the following very rough findings:

- apparently no malaria;
- a little malaria;
- transmission is intense (or was so quite recently).

The rule was to see the greatest possible number of persons, classifying them as "routine examinations" for all-comers or as "suspects" (if they complained or showed signs of possible malaria). Particular attention was given to the detection of cases of the latter kind, which were potentially dangerous.

Contrary to what happens almost everywhere else, it was amongst the school-children - this being the most accessible and least unstable group - that information least affected by errors was collected (at all events, information of a negative character giving a good indication of the healthiness of the place, it being often possible that positive cases had been infected during the holidays or in the course of some other change of place).
The survey was usually conducted as follows:

- detection of enlarged spleens by Hackett's method, children standing, adults lying. (It was only in exceptional cases that we were allowed to slip a hand under the left side of some elderly woman);

- on the one slide, a thick and thin blood smear taken, stained with Giemsa on returning to the laboratory, though occasionally staining was carried out in the field.

Further:

- examination of the slides sent by the rural dispensaries and the hospitals, either "routine" (theoretically all patients not suspected of malaria, carried out for one week in each month); or "suspects" (duplicates of the slides taken for the local laboratories);

- consultation of the monthly reports from these hospitals.

2.3.2 Entomological data

For each district, the following was the procedure:

- establishing contact with the administrative and health authorities with a view to obtaining detailed information concerning possible foci both of malaria and of mosquito swarms and the fixing of the information collected on the 1/500 000-scale map;

- touring the district, visiting the greatest possible number of water points shown on the map (or sometimes indicated by nomads) whether permanent or temporary, natural or artificial;

- the larvae of the anopheles were either identified in the field or preserved in a clarifying liquid for subsequent mounting; when it was possible the pupae were set to hatch out;

- in the various types of dwelling - and sometimes in their natural shelters - adult mosquitoes were collected by spraying a two per cent. solution of pyrethrum concentrate in paraffin; after identification and whenever practicable - the female anopheles (practically always A. gambiae) were subjected to one or more of the following operations:
- examination for sporozoites in the salivary glands;
- the preparation of stomach smears for precipitin tests;
- the dissection of the ovaries of mosquitoes both "fed" and "fasting";
- on rare occasions, mosquitoes were caught by hand in the day-time on the walls of dwelling-places and, especially by night, on human bait;
- finally, collections were systematically made in three huts of the usual type, specially erected near semi-permanent breeding-places; and also in barrels and artificial wells in the neighbourhood (Muirhead-Thomson type).

2.3.3 Other investigations

The pH of the water points visited was systematically ascertained with the help of the Universal Indicator. Lastly, the available meteorological data were collected.

3. OBSERVATIONS

The most striking feature is the extreme diversity and lack of correlation of the results recorded.

3.1 Malarriometry

It must once more be emphasized that it was not possible to obtain really representative samples of the population, not only because of its mobility and its reluctance to undergo examinations, but also through the administrative failure of the "routine" method of blood-taking, which should have been done automatically on all those who came for consultations to hospitals and dispensaries but was rarely done as a routine.

Table II gives the principal results.
### TABLE II

<table>
<thead>
<tr>
<th>Age-groups</th>
<th>Routine examinations</th>
<th>Suspects</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Spleen rate</td>
<td>Parasite rate</td>
</tr>
<tr>
<td>0-11 months</td>
<td>-</td>
<td>10.6 (47)</td>
</tr>
<tr>
<td>1-9 years</td>
<td>14.7 (634)</td>
<td>9.3 (605)</td>
</tr>
<tr>
<td>over 10 years</td>
<td>4.8 (352)</td>
<td>6.1 (684)</td>
</tr>
<tr>
<td>non-classified</td>
<td>-</td>
<td>9.6 (728)</td>
</tr>
<tr>
<td>Averages and standard deviation</td>
<td>11.3 ± 1</td>
<td>8.4 ± 0.6</td>
</tr>
</tbody>
</table>

**N.B.**

- the figures in brackets represent the number of cases on which the percentage was based;

- the percentage of gametocytes was based on the number of positive slides.

The standard deviation calculated as it was from the aggregate percentages, gives a completely erroneous idea of the extent of the real variations in percentages which ranged, according to locality, from 0 to 60 for spleens and from 0 to 80 for parasitaemia. The determination of a figure taking account, in some measure, of the heterogeneity was attempted, as an example, and in view of the difficult nature of the operations, for spleens only. This gave ±14.5 instead of ±1. (This does not give the real limits of the reliable range, but is nearer the reality and permits of the assumption that the indexes do not present obviously significant differences between the various age-groups. At most one might speak of a "tendency"). Because of the lack of co-operation and the small numbers of the observations made, the seasonal incidence could not be clearly estimated. It showed itself, however, in the monthly return of the number of patients seen in the hospitals. In this connexion, the report for 1958 records some rather unusual facts: nearly 32 per cent. of the cases for the whole year occur in the two months of February and March (two-thirds
of them in the district of Borama alone) whereas only 10 per cent. occur in June and July. It is noteworthy that of 1739 patients, 56 per cent. were considered as "clinical cases" and that 13 per cent. of the positive slides were classified as benign tertian. In 1959, Borama was spared and the number of cases for February-March was one-sixth that of the previous year.

Although the percentage of enlarged spleens is higher in children than in adults, the latter were more frequently found to be gametocyte carriers, whereas the parasitaemia rates are similar for the two groups.

The country as a whole has a patchy hypoendemic malaria distribution, with children and adults showing an equal degree of infection with a few scattered hyperendemic foci where premunition also seems to be poorly developed.

Of 245 positive slides examined in the WHO laboratory, P. vivax was found only in 2.4 per cent. of the cases and P. malariae in only 0.8 per cent. (The average for the four previous years for cases verified microscopically gave: P. vivax 21.8 per cent. and P. malariae not recorded).

3.2 Entomological data

Eight species of anopheles have been reported in Somaliland: A. dthali, A. gambiae, A. macmahoni, A. pharoensis (found in 1954 at Zeliah near Djibouti and then not seen again until September 1959, near Hargeisa), A. pretoriensis, A. turkhudi, A. species, (a new species in course of being described).\(^1\)

Of the eight species studied in the course of the present survey, it transpires that though A. dthali and A. turkhudi can attack man in exceptional cases (A. pharoensis was seen only twice), only A. gambiae is so frequently and closely connected with man that it may be held responsible for practically all the cases of malaria observed. In point of fact, it was always found present when small outbreaks of malaria were studied.

3.2.1  *A. gambiae*

3.2.1.1  Morphology

Larvae and adults correspond to the classical descriptions.

3.2.1.2  Distribution

Has been found in a number of places; if circumstances are favourable it can certainly spread and breed almost everywhere.

Its preferred breeding-places are pools, puddles, animal hoofprints; the cisterns form an almost inevitable breeding-place; it is not usually abundant and is difficult to find (Gillies, 1952, had already pointed this out).

It likes fresh water; in gypseous soils, the calcium sulfate concentration in pools increases as they dry up; *A. gambiae* disappears from them whereas *A. dthali* can persist in the same breeding-place almost as long as the water itself though it has become hard.

Sometimes, it is no longer found in pools of fresh water where there was a colony on previous days. Perhaps the reason is to be found in the rapid fall in the water level.

In the approximately 300 permanent natural breeding-places studied - outside the Haud - it was found 54 times:

- alone in 29.6 per cent. of the cases;
- associated with *A. dthali* in 57.4 per cent. (i.e. *A. dthali* alone, 9.3 per cent; *A. dthali* and other anopheles, 48.1 per cent. of the cases);
- or, finally, with other species in 13 per cent. of the cases (never with *A. macmahoni* and *A. species*, whose preferences are very different). The association is not always very close. Thus, it will not be found in the same breeding-place as *A. turkhudi*, which likes to smuggle in a tuft of algae floating on running water, but a few centimetres away, in the print left by the hoof of a camel or some other animal.
It is the only anopheles found in the Haud. Although, after sufficient rains, it would seem to be possible for it to swarm over all the territory, in the dry season it withdraws towards the permanent - or at all events more lasting - water points:

- especially in the mountain range and its foot-hills, particularly to the north of Hargeisa (in 43 per cent. of the breeding-places in this region there were A. gambiae), from which, with the means at present available, it seems almost impossible to eliminate it;

- in a few more or less abandoned wells and a few seashore springs from which it could be dislodged;

- in the cisterns of the Haud, from which its eradication is absolutely essential; (it is difficult to say whether it persists in the wells of the gypseous zone adjoining).

3.2.1.3 The adult anopheles is often difficult to discover because of its rarity. Even in the hyperendemic foci before any insecticide treatment it is not abundant and seems to disappear for weeks on end (particularly when the south-west wind, the Khariff, blows). It is only very exceptionally that more than five are collected, after spraying with pyrethrum, in any one dwelling-place. In 17 months, out of 1549 dwelling-places of all kinds sprayed with pyrethrum (the great majority being huts never previously sprayed), the average collected was 0.57 anopheles per hut. On one occasion, however, 248 females were collected in three huts near a pool in which larvae were swarming (a non-sprayed zone which, when visited seven months earlier, was completely dry and apparently free of mosquitoes of any kind whatsoever).

In zones of potential epidemics (Haud) its outstanding characteristic is its transience which would seem to be connected with the habitually rapid drying up of the pools.

When it was possible to observe it in a state of rest in the huts, it was found especially between the pieces of matting which overlap one another, in their folds, behind the objects cluttering up the house and, occasionally, well in evidence on washed-out surfaces from which the insecticide had disappeared.
A. Its feeding habits have not, so far as feeding-times are concerned, been the subject of any very thorough investigation. From surveys, it appears that it would attack chiefly in the twilight and in the early hours of the night and also at dawn; but it is possible to be bitten in the middle of the night also. On one occasion it attacked us in a swarm as early as 6.30 p.m. and continued to be very abundant until the morning. It was then associated with A. pharoensis in the proportion of 8:1. Its density was, without exaggeration, several hundred per man-night (the region was uninhabited). These attacks occurred both outside and inside the tent and inside the local huts.

The results of the identifications of the blood meals, carried out by the Lister Institute, vary greatly. The average anthropophilia is 0.61 (out of 394 examinations) but it should be noted that, in the case of the swarm mentioned above (248 females in three huts), it was only 0.195 (out of 77), the remaining 0.805 being shared almost equally between the camels, sheep and goats and also the cattle. A zoonoprotection which allows only one mosquito in five to pass through seems to be singularly effective.

B. The appearance of A. gambiae in the Haud, often shortly after the first rains, has until now puzzled all observers but has never yet been quite satisfactorily explained. At the present time, however, one is tempted to assert that, in the cisterns, the anopheles is on the spot ready for breeding in the neighbouring pools. But most of these tanks are of recent construction. How did A. gambiae formerly penetrate to the very heart of the Haud to cause the deadly epidemics that are still keenly remembered? Was the adult carried in the folds of matting rolled up on the backs of the camels? Or was it an example of:

C. Aestivation? This question has never been clarified. It should receive the special attention of entomologists. We would merely point out that:

- examination of the ant-hills gave negative results. But thousands of them would have had to be broken open to be able to form an authoritative opinion on the question;

- in June 1959, in two places in the Haud, at a distance of more than 500 kilometres from each other, five females amongst some 500 "normal" caught in the huts were found in what seemed to be the state of "partial quiescence" described by Büttiker (1958) and had in the stomach a dark red mass like an
almost dry paste. In one case, the neighbouring pool was in a muddy condition; in the other case an abundant larva population was found. The rains had started about six weeks previously and, for a time, would be very intermittent. It seems hard to believe that these females caught in huts that, for the most part, were newly erected - in one case the place was absolutely deserted three weeks earlier - were survivors from the previous dry season. Were they preparing to face, in better conditions, the dry period ahead? It would be necessary to pass weeks uninterruptedly and patiently - on the spot, both at the end and just before the anticipated beginning of the rains, to throw any light on this problem which is no doubt connected - at all events partially - with the appearance of epidemics in "waterless regions".

D. The determination of the susceptibility of *A. gambiae* to insecticides was attempted - in the larval state - in the breeding-place itself. A very high rate of mortality amongst the controls makes it impossible to consider the results obtained as being valid (LD$_{50}$ 0.1 p.p.m. for DDT and $\leq$ 0.02 p.p.m. for dieldrin). The absence of breeding, the transient character of the anopheles and its usual rarity have so far led to the postponement of any attempt to determine the susceptibility or to conduct any bio-test with the adults.

E. Attempts have been made to determine longevity from the proportion of females found to be parous by examination of the tracheal system of ovaries. Of 102 ovaries selected for examination, 67 were found to be parous which - conditions of emergence being uniform and the sample being representative - would correspond to a daily mortality of five per cent. Obviously, thousands of dissections would be necessary to obtain any results worthy of acceptance.

F. In just under 200 dissections of salivary glands no *sporozoite* was detected.
3.3 pH of the water of larval breeding-places

Ninety-seven approximate determinations were made on very different breeding-places. The range of results, in percentages, was as follows: 6.5:1; 7:13.4; 7.5:44.3; 8:30; 8.5:11.3. The only conclusion that could be drawn from these surveys was that \textit{A. gambiæ} avoids highly alkaline water which is frequently the very hard water in which \textit{A. dthalæ} delights.

4. Epidemiological summary

The situation in Somaliland appears to be that of a very unequally distributed hypoendemicity with a few hyperendemic foci, the whole presenting a character of unstable malaria, without premonition, where \textit{P. falciparum} is the most frequent infection encountered, with the possibility of outbreaks of violent epidemics.

The transmission which is due solely to \textit{A. gambiæ} is seasonal, even, it would seem, in foci at permanent water points. Various explanations of this may be given:

- on the coast, during the violent drying wind, the "Khariff", anopheles are very rare and their length of life must be short. This is probably also the case in places in the foot-hills where, moreover, there are an appreciable number of "real houses" which have been treated for years. In these communities transmission seems to have been almost stopped;

- in the mountain range during the cold months the temperature falls enough for the invertebrate cycle of the plasmodium to be seriously slowed up and sometimes made impossible;

- in the Haud, for more than eight months in the year, there is no water except in the cisterns. The apparent suddenness and, from time to time, the seriousness of the epidemics that occur in this region have always surprised the medical officers of the Protectorate. If, however, it is assumed that amongst these apparently healthy nomads who come into the Haud there may be about one per cent. of gametocyte carriers, it can be imagined what is likely to happen after three months of conditions exceptionally favourable for \textit{A. gambiæ}. Professor G. Macdonald (1957)
constructed his theoretical graphs with initial rates only one-tenth as high. He gives us a striking summary of what must happen. The secondary cases develop and spread almost entirely unperceived and, owing to the distances involved and the slowness of communications, when the health authorities are at last called upon, the epidemic has really reached its height.

But, it may be asked, why are these epidemics, on the whole, so rare whereas the immunity they can confer is, apparently, so temporary? The reply would seem to be found, at all events partially, in the fact that the rains are extremely localized. In the season, it often rains in the Haud almost every day, but the rain pours down in pockets scores of kilometres apart and each one affects only a few hundred square kilometres. It follows that very often the pools have dried up before being colonized. Sometimes *A. gambiae* has time to arrive and to develop a few generations and a few secondary cases occur. Then everything dries up again and the epidemic dies out although the number of gametocyte carriers has increased. People and animals then move away in search of greener regions, perhaps taking with them a few anopheles which may cause a further little flare-up, but the rainy season is passing and soon comes to an end without any "real epidemic" being notified to the health authority.

To provide the conditions required for a serious epidemic it seems, therefore, that there would have to be repeated and prolonged rains capable of maintaining good breeding-places for a sufficient length of time. It would seem that this happens somewhat rarely, though not much is known about what occurs in the Ethiopian Haud which is certainly more rainy.

Lastly, the part played by zooprotection must be emphasized. We would recall that the most deadly epidemics have been observed after years of great famine when the herds of livestock had been decimated and had not been reconstituted.

In any case, our interpretation is suggested subject to verification but we have the impression that it is in the Haud, during the rainy season, that the optimum conditions for transmission exist and that it is indeed there - at all events at the present time - that the nomads get their fill of gametocytes. It seems that gatherings near water points where any considerable transmission takes place are relatively rare.
4.1 Discussion

It seems obvious that control of malaria within Somaliland, even if very effective, will never protect the nomads from epidemics outside the political frontiers which they disregard. The only solution is to establish a coherent eradication programme covering the whole of this Horn of Africa. Technically, such a programme could be more easily carried out here than in many regions of equatorial tropical Africa.

Nowadays, in most regions, the main factor in eradication is "total cover" with contact insecticides, so that the longevity of the anopheles - and, as a consequence, its density - are so much reduced that there is very little chance of infectious bites. Here, because of

- the structure of the habitation (the transient nature of the insecticide deposit in the rainy season) and the handling to which it is subjected;

- the anarchical character of the nomadism (in 1958 such a total cover was attempted at the cost of great efforts of personnel and much material but a number of huts nevertheless escaped);

- political conditions (Ethiopian frontier);

- lack of co-operation (refusals are not rare),

this method cannot play the chief part, either in the Haud or in the little mountain encampments. It must, on the other hand, continue to be employed in all stable foci and in all places where there are clear cases of threats of epidemic. What must be done before all else, it seems, is to detect the sufferer and cure him, whether he is setting off for the Haud or coming back from there.

5. A FEW IMMEDIATE PROBLEMS

5.1 Health education

This is really problem number one. Nothing can be done without the co-operation of those concerned.
In this education more use should be made of the radio and the Press and, above all, it should be directed more towards the notables, the élite, the elected representatives of the country who, in practice, do not take the slightest part in the action undertaken. The medical and nursing staff might, no doubt, contribute greater co-operation.

For intensive work, first-aid helpers could be trained and they would follow the tribes when they move from one place to another:

- providing current medical attention;
- detecting the appearance of mosquitos with spotted wings and seeing that encampments are set up beyond flying radius from the nearest water point;
- treating cases of fever immediately;
- reporting without delay to the nearest police patrol (provided with radio link) if there is any likelihood of the situation becoming serious - swarms of anopheles, increasing numbers of fever cases. (Outside the Haud these first-aid helpers would also see that abandoned wells are filled up).

5.2 International political situation

Although, in present circumstances, it would be difficult to foresee a change in this situation, contacts should nevertheless be maintained and strengthened with the staff working under Point IV and with WHO staff working in Ethiopia, just as they are maintained with the medical officers of Somalia and French Somaliland.

It should, however, be borne in mind that no serious or lasting work can be carried out in the Horn of Africa unless there is well co-ordinated joint action.

5.3 Legislation is apparently under consideration. Normally, it should be brought into effect after an intense campaign of health education.
5.4 Antianopheline campaign

We shall confine ourselves to a few suggestions that are perhaps classical in character.

5.4.1 Adult anophels

In the event of a threat of epidemic, an insecticide with fumigant properties which would make it difficult for the insect to live in a hut with many nooks and corners might be indicated. In the second place, the use of insectifuges might be considered after a thorough investigation had confirmed not only their effectiveness but also the fact that the population would be willing to accept them.

5.4.2 Larvae

If antievaporants of the "cetol" type could be used as larvicides they would no doubt - for economic reasons - be favourably welcomed by the owners of the tanks.

5.5 Antiparasite campaign

The organization of the detection, treatment and control of the sick should, together with health education, receive the chief attention of those responsible for the antimalaria campaign in Somaliland.

It is, in a sense, a "surveillance", both active and passive in character, that should forthwith be instituted with determination and perseverance. Systematic mass prophylaxis through the administration of tablets would seem to be quite impracticable except in certain very special cases. On the other hand, the possibilities of introducing the Pinotti method deserve to be studied.

6. CONCLUSIONS

It would seem that malaria could be eradicated without too great difficulty from the greater part of the Horn of Africa provided joint action is undertaken in the three territories concerned. Beforehand, existing obstacles of a non-technical nature must be overcome and the population must be instructed about the co-operation that is expected of it.
7. THANKS

We wish to express our gratitude to the Government of Somaliland, and especially to the Director of Medical Services, Dr W. T. Thom, who did everything in his power to assist us in our work, and also to the Regional Director of the WHO Office in Brazzaville, Dr F. J. C. Cambournac, who was good enough to authorize the publication of the present notes. Our thanks are also due to Mr D. Payne, WHO technician, and to all the Indian, British and Italian national staffs with whom we had the pleasure of working and to our immediate colleagues, in particular, Mr Ismail Hersi, Health Superintendent, for their excellent co-operation and their great kindness.

REFERENCES


Gillies, M. T. (1952) Report on a dry season survey of anopheline breeding in the Haud (Somaliland Protectorate). Not published


MAP OF LARVAL BREEDING-PLACES
(FORMER BRITISH SOMALILAND)

SYMBOLS OF ANOPHELES
- A. azaniae
- A. d’thali
- A. gambiae
- A. macmahoni
- A. pretoriensis
- A. rhodesiensis
- A. turkhudi

- Political frontiers
- Boundaries of zones
- Plateau without permanent water

FRENCH SOMALILAND

DJIBOUTI

SOMALILAND

BOSASSO

GULF OF ADEN

ERIGAVO

HARGEISA

BURAO

LAS ANOD

HORN OF AFRICA

ETHIOPIA

SOMALIA

INDIAN OCEAN

0 50 100 km