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GAMBELLA MALARIA PILOT PROJECT

by

R.E. Fontaine
Senior Malaria Adviser
U.S. International Cooperation Administration, Ethiopia

and

Abdallah E. Najjar
Malaria Adviser
U.S. International Cooperation Administration, Ethiopia

INTRODUCTION

Establishment of the Project

The Gambella malaria project was founded for the purpose of assessing the possibilities of interrupting malaria transmission by residual house spraying in a low-altitude peripheral area of Ethiopia where malaria transmission is more or less continuous throughout the year. The Ministry of Public Health advisory committee and WHO and ICA malarialogists recommended the project after concluding that interruption of malaria transmission was accomplished in malarious areas above 1200 meters, where transmission is seasonal and relatively brief. This conclusion was reached on the basis of epidemiological and operational data gathered in three malaria pilot projects at Kobo-Chercher, Awash and Dembia, in which places transmission reaches a seasonal peak during and immediately following the south-east monsoon rains of July-September. Therefore, the Gambella pilot project is designed to provide information on the feasibility of malaria eradication in another representative geographical region.

Gambella is situated on the Sudan border. The area was selected by the Malaria Advisory Committee after preliminary investigations indicated that malaria is hyperendemic and that the land features, together with other characteristics, made it a suitable location for pilot project purposes.

Financial Considerations

Pursuant to the recommendations made, a project proposal was prepared and submitted to the Economic and Technical Assistance Board. This was approved in June, 1958, for financing under a United States Government economic assistance grant of Eth.\$475,000 which had been earmarked for malaria control activities. Subsequently, on October 15, 1958, the project was officially activated when a deposit of Eth. \$12,000 was made to the project imprest bank account. Active preparations were then undertaken to select personnel, acquire facilities and procure equipment and supplies.

Building space for the project headquarters was made available in an unused section of the Ministry of Public Health dispensary at Gambella, and two adjacent empty outbuildings were acquired in the same compound. The larger of the two buildings serves as bachelor quarters for assigned employees. The smaller building is utilized as an insectary for mosquito rearing and colonization. Repairs and renovations were made and simple sanitary facilities constructed by project employees at a cost probably half that of building by contract.

The governor of Gambella, H.E. Belata Tsehay, was especially helpful and cooperative. He placed his personal Landrover at the disposal of project employees before project vehicles were delivered to Gambella, and also made available an empty brick building as a storehouse for insecticides and equipment.

TECHNICAL PROGRAMME

Prior to the establishment of the project, the only technical record available on the incidence of malaria at Gambella was that reported by Najjar, who found a 75% spleen rate in the 2 - 9 year age group at Gambella on February 28, 1957. On the same date, one hundred blood examinations yielded fifty-two positives, of which 77% were P. falciparum, 4% P. vivax, 8% P. malariae, and 11% mixed infections.

While this preliminary data indicated that malaria is hyperendemic, it was evident that for purposes of a pilot project scheme, additional information would be needed in order to establish a base line against which the effectiveness of a control campaign could be measured. With this objective in view, project activities have been focused primarily on securing epidemiologic

data and conducting geographical reconnaissance in preparation for the initiation of control work in 1960. The following activities have been given special stress in the preliminary investigations:

1. Entomology - Information is being compiled on the bionomics of malarial vector species.
2. Malariaeometry - Data is being accumulated on the seasonal occurrence and intensity of malaria.
3. Climatology - Temperature, relative humidity and rain all is being recorded daily.
4. Geographical reconnaissance - The demography of the population and the cartography of the area, together with the other information needed for planning the control campaign, is being investigated and completed.
5. Control Work - A house spraying campaign limited to the environs of Gambella town was carried out in April 1959 to protect the non-immune resident population, comprising assigned government employees, local business people and their families.

In addition to the activities listed, the staff has been closely engaged in training of local area personnel.

Geographical and Demographic Data

While this information is still in the process of being gathered, the following preliminary data is currently available:

Gambella Muraqa in Illubabor Province lies roughly at an elevation of about 500 meters at the westernmost extension of Ethiopia's boundary along the Sudan. The topography varies from rolling to level grassy savannah, interspersed with scattered trees and brush. On the east, the territory extends to the base of the western escarpment of the central plateau, which rises steeply to an elevation of 1900 meters at Gore. This community is situated about 100 km. directly east of Gambella town.

The Bero is the only major river. At Gambella it flows in a well defined channel about 100 meters wide. It rises in the plateau east of Gambella and flows in a westerly direction, joining the White Nile above Khartoum. During the wet season, it is navigable from Khartoum by river boat to Gambella town, where depths of eight meters are recorded. The depth of the dry season flow is highly variable, but is seldom less than one meter deep.

Misallines parallel the river in many places along the river. These are evidently fed by seepage passing through the narrow width of river bank which rises a few feet higher than the surrounding valley land. These marsh areas are significant in mosquito production, as will be noted under the entomological section of this report.

The river is the lifeline of the region. Fish are abundant and provide one of the primary sources of food for the native population, who live in small settlements built along the river banks. The soil is very fertile in the river valley, which varies from a few hundred meters to several kilometers wide. Ikize, sorghum, papaya, mangoes, bananas and some vegetable crops are grown in garden plots by each settlement.

The dominant ethnic groups are the Nyhak, Nuor Masango and Commo tribes. The combined population is estimated to be from 70,000 - 80,000, occupying the river valley extending about 125 kilometers from Gambella to the Sudan border.

The people are generally tall and lean, with many males reaching two meters in height. Their way of life is simple. Daily work patterns are mostly confined to gardening, fishing, food preparation and housekeeping. Construction of houses and canoes are special occasional tasks. Food appears plentiful and there is an apparent air of contentment among the inhabitants. Their personal hygiene is good. They wear few clothes and bathe and swim daily in the river. Common infections reported other than malaria include tuberculosis, filariasis, onchocerciasis and amoebiasis. Parasite worms - hookworms, roundworms and tape worms - have also been reported.

The Nuor tribe are herdsmen, raising cattle and goats. Their diet is mainly milk and blood, which is drawn fresh by intravenous tapping of one of the neck veins of the larger animals.

The typical dwelling is a mud-walled, circular hut covered by a thatched roof. Smaller open-sided outbuildings are utilized for daytime shelters. These, together with the main hut, form the family compound, which is usually enclosed by a thatched fence held upright by stakes. The central patio area of the compound is a mixture of mud and local binding material which hardens almost to the consistency of concrete. The compounds are kept clean and orderly. There are only a few European-type buildings located in Gambella town and also at the American mission station at Acado, about thirty kilometers down river from Gambella.

Outside Gambella, road conditions are poor. The road leading to Addis Ababa is impassable for about half the distance during the wet season and only partly passable during the dry season. Some trails are negotiable by special purpose vehicles, but only during the dry season months. In the wet season, the

river is the only practical means of transportation.

The Ethiopian Air Lines make a semi-regular round trip from Addis Ababa. This is the only practical link with the outside world.

Climate

The Gambella country is influenced by the Sudan type climate which extends easterly into Ethiopia, nearly as far as Bure-Gore-Ikempt. It is also the dominant climate in the territory west of Gondar and in most of Eritrea.

There are two general seasons, dry and wet. In the wet season, precipitation falls mainly as light to heavy showers from April through October. Maximum rainfall occurs in July and August. The yearly total ranges from 1,000 to 1,400 mm. The seasonal distribution by month is shown in table I.

TABLE I

Seasonal Distribution of Rainfall - In Millimeters
Gambella, Illubabor Province

23 Year Mean

<u>J</u>	<u>F</u>	<u>M</u>	<u>A</u>	<u>M</u>	<u>J</u>	<u>J</u>	<u>A</u>	<u>S</u>	<u>O</u>	<u>N</u>	<u>D</u>
6	9	37	86	154	171	241	236	192	99	44	13

Temperatures are generally very high during the dry season months, reaching to occasional maximum of 45° C. (113 F.). Minimum temperatures are lowest in the wet season, occasionally dropping to about 15° C. (60° F.).

Relative humidity ranges between a minimum of 15% to a maximum of 60% during the peak of the dry season, rising to a minimum-maximum range of 60 to 95% during the wet season months.

The rainfall, temperature and humidity records collected by the project from January through August, 1959 are given in Appendix 1.

Entomology

Systematic observation of mosquito prevalence was first started in January 1959, with the establishment of twenty-eight collecting stations from which aspirator catches are made weekly.

The stations consist of native huts, twelve of which are located in Gambella and sixteen in the surrounding rural area. Collections are limited to twenty minutes per station once weekly.

On the basis of station catches through August 1959, it is concluded that Anopheles funestus and Anopheles gambiae are the two vectors mainly involved in malaria transmission. Anopheles nili and A. pharoensis have been occasionally taken in station catches, but to date never in numbers sufficient to indicate that these species play a significant role in transmission. Anopheles rufipes, Anopheles coustani and A. pretoriensis have also been collected.

The average monthly index of Anopheles funestus and A. gambiae is shown in Table II.

TABLE II

Average Monthly Index of Anopheles Funestus and A. Gambiae
Correlated with the Monthly Mean Maximum Temperature, Relative Humidity
and Total Monthly Rainfall
In the Gambella Area, Illubabor Province

Date 1959	A. Gambiae	A. Funestus	Combined Index	Vector Index*		
				Monthly Mean Max. Temp.F.	Monthly Mean R.H. 8:00 hrs.	Monthly Rainfall mm
January	1.	26.	27.	96.7	70.	Trace
February	1.5	25.	26.5	97.7	61.4	Trace
March	1.	10.	11.	104.2	71.	23.0
April	.75	1.4	2.1	105.9	68.8	19.5
May	1.6	1.7	3.3	96.6	87.2	165.
June	6.	3.8	9.8	88.6	84.4	195.
July	3.	6.	9.	87.9	88.6	168.
August	8.9	11.6	20.5	86.9	90.8	282.

* Index based on collection in rural area outside Gambella Town.

It is evident from examination of the data in Table II that Anopheles funestus is the predominant vector mosquito from January through April. With the commencement of the wet season in May, the Anopheles gambiae index shows a noticeable increase. Conversely, there is a noticeable decline in the A. funestus index. These changes evidently reflect changes in the breeding

habitats induced by the rains and resulting flooding of low land. During the dry season months, marshes and swamps adjoining the Bero River are the only extensive breeding places favoured by Anopheles funestus but which are not conducive to Anopheles gambiae. With the advent of rains, breeding places favourable to Anopheles gambiae are created and the adult population is increased as a result.

The vector index for Gambella Town is given in Table III. Because of the control campaign (DDT residual spray) carried out in late April, 1959 in Gambella Town, this index is kept separately from the general index shown in Table II.

TABLE III

Average Monthly Index* of Anopheles Funestus and A. Gambiae
In Gambella Town, Illubabor Province

	<u>Jan.</u>	<u>Feb.</u>	<u>Mar.</u>	<u>April</u>	<u>May</u>	<u>June</u>	<u>July</u>	<u>Aug.</u>
A. gambiae	2	2.6	.6	.42	.4	0.8	0.8	1.6
A. funestus	15	10.4	3.4	.08	.06	0.1	0.15	.38
Combined Index	17	13.	4.	0.5	0.406	0.9	0.97	2.

* Note: Gambella Town DDT residual spray cycle was carried out from April 27 - May 2, 1959. Mosquito collection stations, upon which the above data is based, were left unsprayed.

Other Mosquito Observations

Resting Habits

Both Anopheles gambiae and A. funestus utilize native dwellings as day-time resting places. They are readily found resting on the interior surfaces of the mud-plastered walls and the underside of the thatched roofs. On the basis of preliminary observations, it appears that adults are resting in greater numbers in poorer constructed huts in which there are many openings in the walls, admitting light and air. The snugly-built dwellings apparently have fewer mosquitoes on the average.

Biting Activity

Outdoor biting by both Anopheles funestus and A. gambiae has been observed. The results of evening catches made in the DDT residual sprayed area of Gambella Town, September 1959, are tabulated in Table IV.

TABLE IV

Night Biting Collection
Gambella Town - September 1959

<u>Species</u>	<u>Outdoor Biting</u> <u>1700-1900 Hours</u> <u>September</u>							<u>Indoor Biting</u> <u>1700-1900 Hours</u> <u>September</u>						
	<u>7</u>	<u>8</u>	<u>11</u>	<u>12</u>	<u>14</u>	<u>15</u>	<u>Total</u>	<u>7</u>	<u>8</u>	<u>11</u>	<u>12</u>	<u>14</u>	<u>15</u>	<u>Total</u>
<u>A. gambiae</u>	1	2	-	-	-	-	3	-	2	-	-	-	-	2
<u>A. funestus</u>	2	3	-	-	-	-	5	-	6	-	-	-	-	6
<u>A. coustani</u>	-	1	-	-	-	-	1	-	-	-	-	-	-	-
<u>Anopheles</u>	2	15	12	13	27	21	89	-	2	3	2	-	2	9
<u>Culex</u>	3	12	3	7	-	-	25	-	6	-	-	1	2	9

Susceptibility Test

The testing of Anopheles gambiae and A. funestus for susceptibility of insecticides yielded results which indicate a low resistance level to DDT and dieldrin. Tests were run in both February and August 1959 with the following results:

<u>February</u>		<u>August</u>	
<u>LD 50 DDT</u>		<u>LD 50 DDT</u>	
<u>A. gambiae</u>	0.64	<u>A. gambiae</u>	
<u>A. funestus</u>	0.58	<u>A. funestus</u>	0.72
<u>LD 50 Dieldrin</u>		<u>LD 50 Dieldrin</u>	
<u>A. gambiae</u>	.042	<u>A. gambiae</u>	
<u>A. funestus</u>	.045	<u>A. funestus</u>	.082

Mosquito Rearing

The rearing of wild-caught Anopheles gambiae has been successfully accomplished through several generations in the project insectary. A. funestus has not been reared to date despite many attempts.

Infectivity

Examination of Anopheles gambiae and A. funestus for oocyst and sporozoites is being carried on as time permits. Out of a total of 625 dissections of engorged A. gambiae and A. funestus, only one A. funestus was found positive for sporozoites in March 1959.

Precipitation Test

Host preference of the vectors is being determined by precipitation tests. Results are not available as yet.

Malariology

The results of blood film examinations of the local populations, together with spleen examinations, indicate that Gambella is hyperendemic for malaria. Available data on parasite rates, together with information on the Plasmodia distribution, is given in Table V.

TABLE V
Comparative Summary of Parasite Findings
In Gambella Town and Environs

1 Date	2 No. Blood* Exam.	3 No. Positive Slides	4 Parasite Rate	5 Plasmodia Distribution				
				F	V	M	Mixed	Un- identified
Feb.25 1957	100	52	52%	75%	2%	8%	10%	4%
Dec. 4 1958	55	31	56%	100%	0	0	0	0
Jan.23- Feb. 6 1959	369	147	50%	91%	4%	3%	2%	0
Mar.18- April 18 1959	322	110	34%	80%	6.4%	4.5%	9%	0
Apr.22- May 18 1959	151	24	16%	54%	25%	8%	13%	0
July 1959	209	49	23%	83%	10%	0	2%	0
August 1959	157	46	29%	71%	15%	7%	7%	0

*Footnote: Blood examinations were made from a cross section of the general population on the following dates: February 25 1957; December 4 1958; and January 23 - February 6 1959. All subsequent findings represent malaria parasite prevalence in outpatients of the Gambella clinic, who are required to submit to a blood film examination, regardless of the cause of admission.

In examining the data under column 4, a sharp decline in the parasite rate is clearly evident from a high of 56% in December 1958 to a low point of 16% in May 1959, after which a noticeable rise occurs in the wet season months of July and August. The vector index given in Table III follows a similar pattern, with the low point being reached about one month earlier in April. This data would indicate that the level of malaria transmission drops to a minimum in April, which is reflected about one month later in the low point of the parasite rate.

Malaria by Age Group

In Table VI, the results of 1664 blood examinations have been tabulated to show the distribution of malaria cases in the different age groups.

TABLE VI
Malaria Cases by Age Group
Based on the Results of Six Surveys
Made During the Period December 1958 - August 1959
Gambella Area, Illubabor Province

<u>Age Group</u>	<u>No.</u> <u>Examinations</u>	<u>No.</u> <u>Positive</u>	<u>%</u> <u>Positive</u>
0-1	84	30	35.7
2-4	100	58	58.
5-9	237	121	51.
10-14	209	76	26.8
15-19	164	37	21.9
20 & Over	<u>870</u>	<u>216</u>	<u>24.8</u>
Totals	1664	538	32.3

An interesting sidelight to the malaria blood examinations in Gambella is the occasional discovery of microfilaria. Thus far, *Onchocerca volvulus* and *Wuchereria bancrofti* have been identified.

Residual Spraying Operations

As mentioned earlier, a house spray operation limited to the confines of Gambella town was carried out in late April to protect the non-immune population comprising government workers, merchants, transients and their family members.

The initial stage of a residual spray operation covering the Gambella rural area of the project is planned for the February-May period of 1960, in conjunction with the provision of geographic and reconnaissance data and other findings indicate that such an operation is both feasible and desirable.

An analysis of the residual spray operations in Gambella is given in Table VII.

TABLE VII

Summary of Residual Spray Operations
Gambella Town
April 27 - May 2, 1959

1. Number of villages	1	No. Structures	917
2. Inhabitants protected	1389	Avg. Surface Area/Structure	53 m ²
3. Employees	7	Spraymen	4
4. Manhours	357	Man Hours (Spraymen only)	204
5. Transportation- Motor Vehicles	2	No. Km. Travelled	150
Average benzine consumed - 2 Km/liter			
6. Equipment used - Hudson X-Port Compression	4		
7. Insecticide: DDT - 75% wettable; Quantity used: 139 kilos; Sq.meters covered - 48.828; Gms./sq.m. - 2.15			

CONCLUSIONS

Until further evidence is accumulated, it would be premature at this time for firm conclusions to be drawn with respect to the malaria problem at Gambella as it relates to the planning and implementation of a control campaign. It is expected that by February 1960, when a full year of fundamental data will have been gathered, that the malaria problem will be sufficiently understood to take up the matter of control and the implications of such work in the Gambella area.