A Second Year's Observation on Malaria in Some Unsanitated Chagres River Villages with Special Reference to the use of Quinine and Plasmochin

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A SECOND YEAR'S OBSERVATION ON MALARIA IN SOME UNSANITATED CHAGRES RIVER VILLAGES WITH SPECIAL REFERENCE TO THE USE OF QUININE AND PLASMOCHIN

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The observations reported in this paper are a continuation of the work done in 1931 in the same region of the Republic of Panama, and published in the Southern Medical Journal, June, 1932 (1) and in the 20th. Annual Report of the Medical Department, United Fruit Company, 1931. In the present paper this will be referred to as the "previous report." There follows a brief recapitulation of the first year's work, and of the nature of the terrain. Five villages in the midbasin of the Chagres River were selected as suitable for our purposes. They contain a population of about eleven hundred, the smallest village, Las Guacas, having about 87, and the largest, New San Juan, about 400. The first year's observations were made to determine the endemic malaria rate, and to obtain other information bearing on the problem of malaria control in such a population. During the second year, monthly surveys were made of the inhabitants, and quinine provided for all those who would take the drug voluntarily, if found positive for malaria. During the third year, the monthly surveys were continued, quinine was administered under more strict control, and in addition plasmochin simplex was administered to as many of the inhabitants as could be reached, in doses of 1 centigram twice a week. One control village, New San Juan, did not receive the plasmochin, but quinine was provided under the same conditions as in the other four villages. The plasmochin was administered in an attempt to prevent mosquito infection, and its value for this purpose checked by mosquito dissections.

The purpose of our work, which should be borne in mind, was to work out some method of malaria control applicable to conditions such as may be found on the plantations of tropical fruit-growing companies, or of oil companies, or other commercial ventures which use large numbers of native laborers. Operating under the necessity of producing dividends for their stockholders, such companies must control malaria to such an extent that it does not interfere with their labor supply, and must do so at a cost low enough to be economically feasible. That malaria in a foreign white population in the tropics can be reduced to negligible proportions, has been amply demonstrated for many years by the Canal Zone health authorities. But these are backed by the resources of the United States, and in 1928 a sum estimated as approximately $116,000 was spent on antimosquito work in the Canal Zone and in the cities of Panama and Colon. This figures out to about 67 cents per capita per year. Such an outlay is out of the question financially for commercial companies operating in the tropics. Hence our efforts were concentrated on the carriers of malaria in the native population, in an attempt to reduce the seedbed from which others may receive the infection.

Monthly blood surveys throughout the year, using thick films, were the yard-stick by which results were measured. In Table I is shown the consolidated malaria rate of the five Chagres River villages by months:

TABLE I

CONSOLIDATED REPORT ON THE FIVE VILLAGES BY MONTHS

(Adults & Children Combined)

Date	Number Exam.	No. Cases Malaria	Malaria Parasite Index	Rainfall in inches at Alhajuela (Madden Dam)
September, 1931	391	91	23.1	17.52
October	339	69	21.5	8.03
November	330	76	23.1	29.23
December	376	59	15.7	4.65
January, 1932	368	83	23.2	1.06
February	423	53	12.2	.22
March	502	83	16.5	.38
April	583	83	14.2	5.74
May	604	90	14.7	17.55
June	543	86	15.8	11.49
July	584	105	17.9	6.79
August	594	74	12.4	11.55
Total 12 Months	5637	952	16.8	114.21 in.
Total previous year	4797	1037	21.6	78.32 in.

In Table II is shown comparison between the rates found in the initial surveys in 1930, the results for 1931, and the results for 1932:

TABLE II

COMPARISON OF MALARIA RATES BEFORE AND AFTER TREATMENT

SANTA ROSA

	Av. No. Exd.	Av. No. Pos.	Per Cent Pos.
Primary survey of children. No treatment. (1929-1930)	63	38	60.3
Av. of 12 children's surveys. Voluntary quinine. 1931	61	16	26.2
Av. of 12 children's surveys. Quinine-plasmochin. 1932	70	16	23.2
Primary survey of adults. No treatment. (1929-1930)	84	39	46.4
Av. of 12 adults' surveys. Voluntary quinine. 1931	36	5	13.9
Av. of 12 adults' surveys. Quinine-plasmochin. 1932	50	7	14

LAS GUACAS

Primary survey of children. No treatment. (1929-1930)	23	11	47.8
Av. of 12 children's surveys. Voluntary quinine. 1931	17	4	23.5
Av. of 12 children's surveys. Quinine-plasmochin. 1932	18	3	16.6
Primary survey of adults. No treatment (1929-1930)	30	13	43.3
Av. of 12 adults' surveys. Voluntary quinine. 1931	20	3	15.0
Av. of 12 adults' surveys Quinine-plasmochin. 1932	27	3	9.7

GUAYABALITO

Primary survey of children. No treatment. (1929-1930)	52	32	55.1
Av. of 12 children's surveys. Voluntary quinine. 1931	49	13	26.5
Av. of 12 children's surveys. Quinine-plasmochin. 1932	73	9	11.8
Primary survey of adults. No treatment. (1929-1930)	58	27	46.5
Av. of 12 adults' surveys. Voluntary quinine. 1931	32	7	21.9
Av. of 12 adults' surveys. Quinine-plasmochin. 1932	40	5	12.3

GATUNCILLO

Primary survey of children. No treatment. (1929-1930)	34	14	41.1
Av. of 12 children's surveys. Voluntary quinine. 1931	28	9	32.1
Av. of 12 children's surveys. Quinine-plasmochin. 1932	39	10	25.6
Primary survey of adults. No treatment. (1929-1930)	26	4	15.3
Av. of 12 adults' surveys. Voluntary quinine. 1931	24	5	21.0
Av. of 12 adults' surveys. Quinine-plasmochin. 1932	40	5	11.8

NEW SAN JUAN

Primary survey of children. No treatment. (1929-1930)	88	52	59.1
Av. of 12 children's surveys. Voluntary quinine. 1931	71	16	22.5
Av. of 12 children's surveys. Quinine-plasmochin. 1932	71	14	20.0
Primary survey of adults. No treatment. (1929-1930)	141	43	30.5
Av. of 12 adults' surveys. Voluntary quinine. 1931	61	8	13.1
Av. of 12 adults' surveys. Quinine-plasmochin. 1932	49	6	11.4

CONSOLIDATED VILLAGES

Children. Primary surveys. Before treatment	260	147	56.5
Children. After 1 year of voluntary quinine, 1931	226	58	25.6
Children. After 8 months of quinine plasmochin, 1932	271	56	20.9
Adults. Primary surveys. Before treatment	339	126	37.2
Adults. After 1 year of voluntary quinine, 1931	173	28	16.2
Adults. After 8 months of quinine-plasmochin, 1932	205	29	14.1
GRAND TOTALS:			
Primary surveys. Before treatment	599	273	45.6
After 1 year of voluntary quinine, 1931	399	86	21.6
After 8 months quinine-plasmochin, 1932	478	80	16.8

From an initial rate of 45.6 per cent the rate has fallen to 16.8 per cent in 1931-1932. This reduction is not due to seasonal variations, as was determined by comparison with rates obtained in other parts of the Republic of Panama in 1931 and 1932. These are in part reproduced by courtesy of Dr. Paul Carley of the International Health Division of the Rockefeller Foundation:

Locality	Date	Per cent Positive	Date	Per cent Positive	Observer
Nombre de Dios	July, 1931	68.8	July, 1932	75.5	(Komp)
El Real	Aug. 1931	29.9	Sept. 1932	38.4	(Carley)
San Miguel	Sept. 1931	73.9	Sept, 1932	83.3	"
La Palma	Aug. 1931	63.9	Sept. 1932	51.4	"
Garachine	Sept. 1931	72.5	Sept. 1932	58.5	"
Yavisa	Sept. 1931	10.7	Sept. 1932	40.6	"

As a further check on our rates, the malaria rates obtained in surveys of areas adjacent to the Madden Dam were compared. These are given in the following table:

TABLE III

MALARIA RATES ON MADDEN DAM HIGHWAY

BY MONTHS.

	Aguas Buenas			Buenos Aires			Chilibre			Madden Dam Road			Totals		
September 1931	81	21	25.9	39	13	33.3	144	62	43.1	168	44	26.2	432	140	32.5
October	84	13	15.5	46	8	17.4	164	45	27.4	149	42	28.2	443	108	22.7
November	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
December	88	16	18.2	47	14	29.8	169	32	18.9	166	39	23.5	470	101	21.3
January 1932	98	19	19.4	23	4	17.4	142	38	26.8	179	37	20.6	442	98	22.2
February	80	9	10.1	34	5	14.7	151	35	23.2	194	33	17.0	459	82	17.9
March	92	4	4.3	25	5	20.0	175	39	22.3	189	23	12.2	481	71	14.7
April	116	9	7.8	46	5	10.9	166	23	13.9	202	27	13.3	430	64	14.9
May	97	5	5.2	42	5	11.9	155	14	9.0	210	23	10.9	504	47	9.4
June	102	5	10.3	86	16	18.6	140	26	18.0	179	23	12.8	507	70	14.0
July	97	10	13.1	51	12	23.5	161	39	22.2	206	23	11.2	515	74	14.3
August	130	17	7.6	50	5	10.0	203	45	12.3	251	28	11.2	634	95	14.9
Totals	1065	128	12.0	489	92	18.8	1770	398	21.9	2093	342	16.4	5417	950	17.5

In this area, treatment was supervised by the Health Office of The Panama Canal. Every positive discovered in monthly surveys received one centigram of plasmochin per week and 10 grains of quinine sulphate per day for 30 days. We can note no difference between results obtained by this method and those brought about by our own.

This area is similar to the area of the river villages, the type of population is the same, and they are not more than 4 or 5 miles apart. They illus-

trate, however, to a greater degree than do our river villages, the great difficulty in carrying out any treatment plan, because of the rapid turnover in population during the year.

METHODS OF TREATMENT

Quinine sulphate powder was placed in the hands of an intelligent woman selected by the people of the village, in each of our five river villages, with instructions to give it to any persons sick with "fever", and to all positives found in the monthly blood surveys. A list of names of these positives was furnished, and each woman "nurse" was required to see her "patients" daily and make sure they took the quinine. As might be expected, this method of quinine administration was not as effective as could be wished, but we felt it was the only method practicable under field conditions. Many cases failed to clear up under quinine, especially among the smaller children, and in these cases the supposition is perhaps well-founded that all did not receive sufficient of the drug. Thus in four of the river villages there were 25 cases who during the past year were positive for three months in succession, 9 who were positive for 4 successive months, 1 positive for 5 months, 4 positive for 6 months, and 3 postive for 7 months, making a total of 42 out of 346 cases who were positive for 3 successive months or more. In addition to these, there were very many more who were positive at intervals throughout the year. In many refractory cases we administered the quinine ourselves, so we were certain that the patient received it.

Plasmochin Treatment: Plasmochin was administered for its power to prevent mosquito infection (2) (3), not because it was hoped that it would exert any curative effect in the small dose, one centigram twice a week, that we gave. In order to have a more accurate check on the administration of plasmochin, and to be sure it was really taken, one or the other or both of the authors personally visited the four river villages twice weekly during the first eight months of 1932. We personally administered the plasmochin, in centigram doses, to a very large proportion of the inhabitants, children and adults alike. No difficulty was experienced in getting the people to take the drug, and in no case were any untoward results noted during the eight months. A supply of the drug was left at each town, and between visits a dose was given to those persons missed on the regular treatment day, by the town "nurse." Each person had a card, on which was entered his age, sex, house number, and a record of any illness occurring during the year, together with a record of his blood survey. On this card the date on which he received his dose of plasmochin was entered. In all, 387 persons took at least 75 per cent of the treatment, out of a total number of about 680. Of the remainder, a very large percentage received plasmochin over varying periods of time, and all received some of the drug at one time or another. Here again the difficulty caused by the transient nature of the population was experienced. Many of the 680 permanent inhabitants on our regular treatment lists moved during the year to other places, or visited their up-river farms for more or less extended periods of time, where they were exposed to malaria infection, and not under plasmochin treatment.

Several interesting facts emerged from this work with plasmochin. First, it did not prevent relapse in cases whose blood had been made negative with quinine. Second, it did not prevent crescent formation during such relapse. This is in accord with the experience of many authors, who have noted the appearance of crescents in patients receiving as much as 6 centigrams of plasmochin daily. Third, infected mosquitoes were found in two of the villages under plasmochin treatment. Only one mosquito of the four so found proved to be heavily infected. In this about 15 oöcysts were found. In the other three, only one or two oöcysts were found in each. The finding of infected mosquitoes may mean that the dose was insufficient to prevent infection, or that the drug was not taken in every case, or that an introduced carrier not under plasmochin treatment infected the mosquitoes.

The crescent rate was reduced by half, in the four villages receiving plasmochin, when compared with the control village.

During the last 10 months of our observations the crescent rate in all E. A. cases in the plasmochin-treated towns was 9.0 per cent. In the same period the rate in the control town was 11.0 per cent. However, if we take the last 6 months of the period as being the effective duration of the plasmochin administration (March-August 1932), we find the rate in the plasmochin-treated towns to be 4.5, and 9.2 in the control town.

A similar drop in crescent rate was found in Chilibre, a town treated by the Panama Canal Health Department. Here all positives found in monthly surveys were treated with 10 grains of quinine sulphate daily, and 1 centigram of plasmochin weekly, for 4 weeks. The crescent rate for 10 months was 17.7 per cent, and for the last 6 months was 9.1 per cent, very nearly approximating the 50 per cent reduction found in our plasmochin-treated towns.

It is doubtful whether any part of this decrease in numbers of crescent-carriers can be attributed to the administration of plasmochin in whatever dosage, for the numbers of crescent-carriers found in the control town, New San Juan, totaled only 10 during the last six months of the treatment period, and large variations occurred in the crescent rate, ranging from 0.0 per cent to 27.8 per cent. It is therefore considered unsafe to draw any conclusions from such meager data.

OBSERVATIONS ON TYPE OF MALARIA, AGE, INCIDENCE, RELAPSE, INTENSITY, IMMUNITY.

From the great mass of material gathered during the year we have extracted certain observations of interest. First, we have confirmed again that the most prevalent type of malaria in the lowlands of Panama is estivo-autumnal. Table V shows the incidence of the various types as found in our surveys.

TABLE IV

SPECIES OF MALARIA PARASITES

Found in 12 monthly surveys of 5 villages.

Date	P. falciparum	P. vivax	P. malariae	Total
Sept., 1931	81	16	8	105
Oct.	57	9	2	68
Nov.	52	6	9	67
Dec.	45	10	4	59
Jan., 1932	64	17	2	83
Feb.	45	8		53
March	66	17		83
April	71	11	1	83
May	69	21		90
June	76	10		86
July	97	8		105
August	70	3	1	74
Totals	793	136	27	956
Per cent	82.9	14.2	2.8	
Totals for previous year	701	264	59	1037
per cent	67.6	25.4	5.7	

It is quite probable that the estivo-autumnal rate as reported is somewhat higher than is actually the case, as all slides showing small rings only are counted as E-A cases, the tertian and quartan cases being diagnosed on the presence of schizonts or sporulating forms. Mixed cases formed a negligible portion of all positives, and are disregarded in our tabulation. Noteworthy is the large number of persons who were positive only once during the year who showed no symptoms, and who had but one or two rings to the entire thick-blood film. Of our 476 cases ocurring in permanent inhabitants, 109 were positive only once during the year, and then with only one or two rings. How many of these 109 cases are "false positives" it is impossible to state.

Of particular interest is the result of examinations of infants under one year, as it has a direct bearing on the probability of new infections. We were able to examine 15 infants born during the year. Each child was examined on an average of nearly four times during the 12 months. Only 3 children were found positive for malaria, all having E-A rings. These children were 2 months, 6 months, and 7 months old respectively when positive for the first time.

That fact that young children show malaria infection has a definite bearing on the prob'em of relapses. As was noted in our "previous report", the more times an individual is examined, the more likely he is to prove positive during the course of the year. This is also true of our results for the present year. A population heavily infected with malaria from early childhood will doubtless show many more cases due to relapse from initial infection, than will one in which malaria assumes a more epidemic form. That our efforts have been productive of good results in suppressing such relapses may be seen from the fact that we have, among our 346 permanent inhabitants, in four river villages, 14 individuals who had negative blood-smears throughout the year. There were also 11 individuals examined 11 times, and 14 individuals examined 10 times, and found negative throughout.

In our "previous report", we noted that 181 individuals who were examined at least 8 times during the 12 calendar months, gave a malaria rate of 92.3 per cent. This year, 301 individuals examined at least 8 times gave a rate of only 68.4 per cent.

Intensity of Infection. Malaria as a Disabling Illness.

In a previous paragraph we called attention to the fact that a great many of our positives were of the 1 or 2-ring type. A certain proportion of these persons undoubtedly had malaria, although just how many, is impossible to state. We can say, however, with a high degree of assurance, that serious illness may result from malaria, even in such a population as we are considering. The accompanying table (Table 6) gives the number of cases of malaria of hospital intensity type we encountered in our surveys:

TABLE V

CASES OF HOSPITAL INTENSITY TYPE

	Las Guacas	Santa Rosa	Guayabalito	Gatuncillo	N. San Juan	Total
Sept.	1	3	6	3	4	17
Oct.			1			1
Nov.		4	1	2	4	11
Dec.		1	1			2
Jan., 1932		5	1	3	1	10
Feb.		1	3	2		6
March		1	4	3		8
April			1	1	3	5
May		4	1		4	9
June	1	5	2	1		9
July	1	6	3		3	13
August		7	1	6	6	20
	3	37	25	21	25	111

This table demonstrates that there is no seasonal tendency in intensity of malaria infection. However, the element of chance enters here, for an individual may have many parasites in his blood on one day, and few the next. Among all positives found in our surveys, about 1 in every ten is of hospital intensity type.

The number of crescent carriers found in the course of our surveys is of interest as showing the possibilities of mosquito infection.

TABLE VI

INCIDENCE OF P. FALCIPARUM CRESCENTS

Five Chagres River Towns.

	No. of E. A. cases	Number of Crescent carriers	Monthly Rate
September, 1931	92	22	23.8
October	67	14	20.9
November	75	15	20.0
December	53	10	18.8
January, 1932	64	19	29.7
February	68	2	2.9
March	62	2	3.2
April	58	1	1.7
May	69	8	11.6
June	62	6	9.7
July	80	1	1.3
August	71	8	11.1
TOTALS	821	108	13.2

Table VI shows 28 more cases of estivo-autumnal malaria than does Table V, "Species of Malaria Parasites", for in it are included a number of transients who do not appear in the latter table. About 13 per cent of all E-A positives show crescents. There seems to be some indication of a seasonal prevalence of crescents during the late fall, winter, and early spring months. This is borne out to a certain extent by last year's figures, but there the trend is not so noticeable. The figures for last year show that 22.9 per cent of all E-A cases showed crescents.

IMMUNITY

While on the whole malaria does not usually produce disabling illness in a native population like the one under consideration, nevertheless, it occasionally causes illness sufficient to bring the patient to bed. We have records of 24 such cases in four of the river villages during the year. Of special interest are the cases of three elderly persons, one a woman of 66 years, and two men, one 54 and another 67, all of whom had heavy estivo-autumnal infections, the woman being positive for three months.

OBSERVATIONS ON ANOPHELES MOSQUITOES

During the season, observations on **Anopheles albimanus** were made, both as to breeding and as to numbers of adults present. Opportunities for breeding were abundant in the shallow lagoons of the Chagres River near the 4 plasmochin-treated towns. The favored breeding-grounds were mats of **Chara** which occurred over large areas in shallow water towards the end of the dry season, in March. Other breeding-places were among floating islands of water-cabbage, and to a lesser extent in shallows in small wetweather streams running through the towns themselves. The towns varied greatly in the number of Anopheles present, and the variation bore no direct relation to the malaria rate. In Las Guacas, the smallest town, which had the lowest malaria rate, the Anopheles incidence was highest. Often hundreds were caught in one night by native boys trained to this work. On the contrary, in New San Juan, **Anopheles** were hard to find. On many occasions the junior author examined with flashlight and tube-catcher all houses in the town, to the number possibly of 90 to 100, and got only 6 mosquitoes. The highest number ever obtained in this town was 19. The other two towns apparently had about equal numbers of mosquitoes. In Santa Rosa as many as 20 were caught in one rather open, cane-walled, palm-thatched hut. In this connection it was noted that the number of people, especially of children, sleeping in the house, had more effect on the numbers of mosquitoes harboring there than did the construction of the house. This fact ties in with the observation made in our "previous report", that those living with large families were much more liable to have malaria. This is probably due to the increased attraction of large numbers of persons for mosquitoes.

Mosquito catches for dissection purposes were made by two means, trapping and hand-catching. We trapped sleeping-quarters in two villages, utilizing the Bath-LePrince trap, at first having the opening facing the outer air. Catching nothing in this way, we added another identical trap, but with its opening facing into the sleeping-quarters. All our mosquitoes taken in traps were caught in traps placed in this latter fashion. Hand-catches were made in the usual manner, with flashlight and tube-catcher. Altogether 952 **Anopheles albimanus** were dissected by the junior author during the period January to September, 1932 inclusive. Of these, 120 were from the control town, New San Juan, which did not receive plasmochin treatment. One of these was found infected, giving a rate of 0.83 per cent. From the other four towns under plasmochin 832 **Anopheles albimanus** were dissected, and 4 infected individuals were found, giving a rate of 0.48 per cent, about half that of New San Juan. The numbers, however, are comparatively small, and a longer series might show a different result. In every case but one we can trace the source of the mosquito infection. One positive mosquito was taken from the trap in the bedroom in which slept a crescent-carrier, discovered in a survey made three days before the mosquito was captured. In another case the sister of the native mosquito-catcher had numbers of crescents in her blood. In a third case, one of the catchers himself suddenly began to produce numbers of crescents, and as he caught mosquitoes in his own house, doubtless he infected one of them. In one case, however, we cannot trace the crescent-carrier, for none was found in the monthly survey which just preceded the capture of the infected specimen. Here the supposition must be that a transient crescent-carrier, not picked up in our blood-survey, stayed in town long enough to infect mosquitoes. In all these cases we may be permitted to doubt whether plasmochin was taken, although we have no direct evidence either way.

The following table (Table VII) gives the number and distribution of the dissections and the positives over the year.

TABLE VII

MOSQUITO DISSECTIONS, JANUARY—SEPTEMBER, 1932.

1932	N. San Juan	Santa Rosa	Guayabalito	Gatuncillo	Las Guacas	Total
Jan.		2				2
Feb.		1				1
March		10				10
April		8				8
May	15	11	4			30
June	11	10	52			73
July	14	43 (1 P)	105 (1 P)	17	8	187
August	24 (1 P)	46	59	33	138	300
Sept.	56	78 (1 P)	68 (1 P)	54	85	341
Total	120	209	288	104	231	952
No. Pos.	1 P.	2 P.	2 P.			5 P.
Rate	0.83	0.95	0.89			0.52

It will be noted that infections were found only after June. This checks with the results of dissections made by the junior author in 1931 of mosquitoes caught in certain Army barracks in the Canal Zone. Here the first infected mosquito was taken in July.

Little seasonal variation in numbers of mosquitoes caught in houses was noted in spite of very large variations in rainfall between wet and dry seasons. This may be due to the increased opportunities for breeding during the dry season, furnished by extensive mats of **Chara** in the shallow river lagoons, which form ideal breeding-grounds for **Anopheles albimanus.** The only other Anopheline species encountered in house-catches was **Anopheles punctimacula,** which is not a malaria carrier, so far as our present knowledge goes.

SUMMARY

(1)—The same five villages observed during 1930-1931 were used during the present year. Thick blood-film surveys were made at monthly intervals. All those found positive were treated with quinine sulphate, and in addition, all inhabitants of four villages received 1 centigram of plasmochin twice a week, one control village receiving no plasmochin. The average of 12 monthly surveys shows a reduction of the malaria rate to approximately one-third its primary incidence. This occurred in the face of a stationary malaria rate in a number of unsanitated areas in other parts of Panama.

(2)—Malaria rates on Madden Dam Highway, in an area adjacent to our river villages, the positive malaria cases in which received only 1 centigram of plasmochin per week in addition to quinine sulphate, showed a malaria rate approximately equal to our five villages (17.5% and 16.8% respectively).

(3)—Monthly surveys on all inhabitants of the river villages show a decided increase in the number of those who did not show malaria at any time during the 12 months. During the previous year, 93.3 per cent of all persons examined at least eight times during the year showed the presence of malaria parasites. During the past year, only 68.4 per cent examined at least eight times showed the presence of parasites.

(4)—The number of cases of "hospital intensity type" was reduced from 173 during the previous year to 111 during the past season.

(5)—The monthly incidence of crescents seems to show a tendency to increase during the late fall, winter and early spring months.

(6)—Mosquito dissections in the five river villages showed, so far as our observations go, that the rate in the control village not receiving plasmochin was twice that of the four villages in which it was administered. In spite of continued plasmochin administration, four infected mosquitoes were found in two of the villages receiving this drug over the period of our observations. No correlation could be established between mosquito density and malaria rate. Las Guacas, where **Anopheles** were most plentiful, had the lowest rate, and San Juan, where they were exceedingly scarce, had a rate equal to the total rate in all five villages.

The rainfall in the area of the 5 villages this last year was approximately twice that of the previous year. This would lead to an increased water area suitable for mosquito breeding, which might be counterbalanced by the flushing action of river floods.

(7)—In view of the high cost of the drug and the large labor force involved in coastal plain tropical organizations, the administration of plasmochin under field conditions, where more strict control is impossible, does not seem justified by our results in the four river villages. A similar conclusion is reached concerning the results of administering plasmochin to positives, only, as in the Madden Dam Highway area.

Among the employees at Madden Dam where quinine and plasmochin were administered in the same amounts as on the Madden Dam Highway, but under strict supervision, the malaria rate among adult men was only 2.6 per cent for the first 8 months of 1932.
We consider the decrease in malaria rates during the past two years to be due to increased efficiency in the use of quinine, rather than to any other single factor involved.

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ADDENDUM

Since the completion of this paper, a paper by Kingsbury and Amies on a similar project has come to our notice. The paper is entitled "A Field Experiment on the Value of Plasmoquine in the Prophylaxis of Malaria," and may be found in the Transactions of the Royal Society of Tropical Medicine and Hygiene, November 30, 1931, Volume 25, Number 3.

They gave 4 centigrams of plasmochin twice weekly for 12 months (four times the quantity we gave). The incidence of clinical malaria was reduced from 30.4 per cent in E-A, and 52.2 per cent in tertian, to 7.0 and 8.7 per cent respectively.

From a consideration of the parasite rates alone, their results were inconclusive, as there was an equal reduction in rate in a control estate.