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

By

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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)

<table>
<thead>
<tr>
<th>Date</th>
<th>Number Examined</th>
<th>Number of Cases</th>
<th>Malaria Parasite Index</th>
<th>Rainfall in inches at Alhajuela (Madden Dam)</th>
</tr>
</thead>
<tbody>
<tr>
<td>September, 1931</td>
<td>396</td>
<td>91</td>
<td>23.1</td>
<td>17.52</td>
</tr>
<tr>
<td>October</td>
<td>373</td>
<td>69</td>
<td>21.5</td>
<td>8.09</td>
</tr>
<tr>
<td>November</td>
<td>363</td>
<td>76</td>
<td>23.1</td>
<td>29.23</td>
</tr>
<tr>
<td>December</td>
<td>376</td>
<td>59</td>
<td>15.7</td>
<td>4.65</td>
</tr>
<tr>
<td>January, 1932</td>
<td>368</td>
<td>83</td>
<td>23.2</td>
<td>1.06</td>
</tr>
<tr>
<td>February</td>
<td>423</td>
<td>53</td>
<td>12.2</td>
<td>2.22</td>
</tr>
<tr>
<td>March</td>
<td>502</td>
<td>83</td>
<td>16.5</td>
<td>.38</td>
</tr>
<tr>
<td>April</td>
<td>583</td>
<td>83</td>
<td>14.7</td>
<td>5.74</td>
</tr>
<tr>
<td>May</td>
<td>604</td>
<td>90</td>
<td>14.7</td>
<td>17.55</td>
</tr>
<tr>
<td>June</td>
<td>543</td>
<td>86</td>
<td>15.8</td>
<td>11.49</td>
</tr>
<tr>
<td>July</td>
<td>584</td>
<td>105</td>
<td>17.9</td>
<td>6.79</td>
</tr>
<tr>
<td>August</td>
<td>594</td>
<td>74</td>
<td>12.4</td>
<td>11.55</td>
</tr>
</tbody>
</table>

Total 12 Months: 5637
Total 12 Months: 952

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**

| Primary survey of children, no treatment. (1929-1930) | 63 | 38 | 60.3 |
| Voluntary quinine. 1931 | 61 | 16 | 26.2 |
| Av. of 12 children's surveys. Quinacrin. 1932 | 70 | 16 | 23.2 |
| Primary survey of adults. (1929-1930) | 84 | 39 | 46.4 |
| Av. of 12 adults' surveys. Quinacrin. 1931 | 36 | 5 | 13.9 |
| Av. of 12 adults' surveys. Quinacrin. 1932 | 50 | 7 | 14 |

**LAS GUACAS**

| Primary survey of children. no treatment. (1929-1930) | 23 | 11 | 47.8 |
| Av. of 12 children's surveys. Quinacrin. 1928 | 17 | 4 | 23.5 |
| Av. of 12 children's surveys. Quinacrin. 1927 | 18 | 3 | 16.6 |
| Primary survey of adults. (1929-1930) | 30 | 13 | 43.3 |
| Av. of 12 adults' surveys. Quinacrin. 1931 | 20 | 3 | 15.0 |
| Av. of 12 adults' surveys. Quinacrin. 1932 | 27 | 3 | 9.7 |
CONSORTIUM VILLAGES

GUAYABALITO

Primary survey of children.
No treatment. (1929-1930) 52
Av. of 12 children’s surveys, Quinine-plasmochin. 1932 73 9 11.8
Av. of 12 children’s surveys, Voluntary quinine. 1931 49 13 26.5
Av. of 12 children’s surveys. Quinine-plasmochin. 1932 40 5 12.3

GATUNCILLO

Primary survey of children.
No treatment. (1929-1930) 34
Av. of 12 children’s surveys, Voluntary quinine. 1931 28
Av. of 12 children’s surveys. Quinine-plasmochin. 1932 39 10 25.6
Primary survey of adults.
No treatment. (1929-1930) 26
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) 85
Av. of 12 children’s surveys, Voluntary quinine. 1931 71
Av. of 12 children’s surveys. Quinine-plasmochin. 1932 71 14 20.0
Primary survey of adults.
No treatment. (1929-1930) 141
Av. of 12 adults’ surveys, Voluntary quinine. 1931 61 8 13.1
Av. of 12 adults’ surveys. Quinine-plasmochin. 1932 49 6 11.4

GRAND TOTALS:
Primary surveys. Before treatment 599 273 45.6
After 1 year of voluntary quinine, 1931 399 86 21.6
After 8 months of 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.

<table>
<thead>
<tr>
<th>Locality</th>
<th>Date</th>
<th>Positive Date</th>
<th>Positive server</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nombre de Dios</td>
<td>July 31</td>
<td>July 1932 75.5</td>
<td>(Komp)</td>
</tr>
<tr>
<td>El Real</td>
<td>Aug 31</td>
<td>Sept 1932 38.4</td>
<td>(Carley)</td>
</tr>
<tr>
<td>San Miguel</td>
<td>Sept 31</td>
<td>Sept 1932 83.3</td>
<td></td>
</tr>
<tr>
<td>La Palma</td>
<td>Aug 31</td>
<td>Sept 1932 51.4</td>
<td></td>
</tr>
<tr>
<td>Carachique</td>
<td>Sept 31</td>
<td>Sept 1932 54.5</td>
<td></td>
</tr>
<tr>
<td>Yavisa</td>
<td>Sept 31</td>
<td>Sept 1932 40.6</td>
<td></td>
</tr>
</tbody>
</table>

As a further check on our rates, the malarial 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.

<table>
<thead>
<tr>
<th></th>
<th>Agua Buenas</th>
<th>Buenos Aires</th>
<th>Chilibre</th>
<th>Madden Dam Road</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>September 1931</td>
<td>81</td>
<td>21</td>
<td>39</td>
<td>13</td>
<td>168</td>
</tr>
<tr>
<td>October</td>
<td>84</td>
<td>13</td>
<td>46</td>
<td>8</td>
<td>164</td>
</tr>
<tr>
<td>November</td>
<td></td>
<td></td>
<td>39</td>
<td>13</td>
<td>168</td>
</tr>
<tr>
<td>December</td>
<td>88</td>
<td>16</td>
<td>47</td>
<td>14</td>
<td>169</td>
</tr>
<tr>
<td>January 1932</td>
<td>98</td>
<td>19</td>
<td>23</td>
<td>4</td>
<td>142</td>
</tr>
<tr>
<td>February</td>
<td>80</td>
<td>9</td>
<td>34</td>
<td>5</td>
<td>151</td>
</tr>
<tr>
<td>March</td>
<td>92</td>
<td>4</td>
<td>25</td>
<td>5</td>
<td>127</td>
</tr>
<tr>
<td>April</td>
<td>116</td>
<td>9</td>
<td>46</td>
<td>5</td>
<td>101</td>
</tr>
<tr>
<td>May</td>
<td>97</td>
<td>5</td>
<td>42</td>
<td>5</td>
<td>107</td>
</tr>
<tr>
<td>June</td>
<td>102</td>
<td>5</td>
<td>86</td>
<td>16</td>
<td>178</td>
</tr>
<tr>
<td>July</td>
<td>97</td>
<td>10</td>
<td>51</td>
<td>12</td>
<td>161</td>
</tr>
<tr>
<td>August</td>
<td>130</td>
<td>17</td>
<td>76</td>
<td>5</td>
<td>203</td>
</tr>
</tbody>
</table>

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 grams 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-
tate, 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 anyone 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 positive 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 upriver 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 oöcyts were found. In the other three, only one or two oöcyts 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-annual. Table V shows the incidence of the various types as found in our surveys.
TABLE IV
SPECIES OF MALARIA PARASITES

<table>
<thead>
<tr>
<th>Date</th>
<th>P. falciparum</th>
<th>P. vivax</th>
<th>P. malariae</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sept., 1931</td>
<td>61</td>
<td>16</td>
<td>8</td>
<td>85</td>
</tr>
<tr>
<td>Oct.</td>
<td>57</td>
<td>9</td>
<td>2</td>
<td>68</td>
</tr>
<tr>
<td>Nov.</td>
<td>52</td>
<td>6</td>
<td>9</td>
<td>67</td>
</tr>
<tr>
<td>Dec.</td>
<td>45</td>
<td>10</td>
<td>4</td>
<td>59</td>
</tr>
<tr>
<td>Jan., 1932</td>
<td>64</td>
<td>17</td>
<td>2</td>
<td>83</td>
</tr>
<tr>
<td>Feb.</td>
<td>45</td>
<td>5</td>
<td>2</td>
<td>52</td>
</tr>
<tr>
<td>March</td>
<td>56</td>
<td>17</td>
<td>3</td>
<td>76</td>
</tr>
<tr>
<td>April</td>
<td>71</td>
<td>11</td>
<td>1</td>
<td>83</td>
</tr>
<tr>
<td>May</td>
<td>69</td>
<td>21</td>
<td>1</td>
<td>91</td>
</tr>
<tr>
<td>June</td>
<td>76</td>
<td>10</td>
<td>1</td>
<td>87</td>
</tr>
<tr>
<td>July</td>
<td>97</td>
<td>8</td>
<td>1</td>
<td>106</td>
</tr>
<tr>
<td>August</td>
<td>70</td>
<td>3</td>
<td>1</td>
<td>74</td>
</tr>
<tr>
<td>Totals</td>
<td>793</td>
<td>135</td>
<td>27</td>
<td>956</td>
</tr>
<tr>
<td>Per cent</td>
<td>82.9</td>
<td>14.2</td>
<td>2.8</td>
<td></td>
</tr>
<tr>
<td>Totals for previous year</td>
<td>701</td>
<td>264</td>
<td>59</td>
<td>1024</td>
</tr>
<tr>
<td>per cent</td>
<td>67.6</td>
<td>25.4</td>
<td>5.7</td>
<td></td>
</tr>
</tbody>
</table>

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 occurring 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 problem 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 846 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 92.8 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 VI) gives the number of cases of malaria of hospital intensity type we encountered in our surveys:

TABLE V
CASES OF HOSPITAL INTENSITY TYPE

<table>
<thead>
<tr>
<th>Las Guacas</th>
<th>Santa Rosa</th>
<th>Guayaquil</th>
<th>Gatupe</th>
<th>N. San Juan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sept.</td>
<td>1</td>
<td>3</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Oct.</td>
<td>1</td>
<td>7</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Nov.</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Dec.</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Jan., 1932</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Feb.</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>March</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>April</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>May</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>June</td>
<td>1</td>
<td>5</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>July</td>
<td>1</td>
<td>6</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>August</td>
<td>7</td>
<td>1</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Totals</td>
<td>3</td>
<td>37</td>
<td>25</td>
<td>21</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>No. of E. A. cases</th>
<th>Number of Crescent carriers</th>
<th>Monthly Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>September, 1931</td>
<td>92</td>
<td>22</td>
</tr>
<tr>
<td>October</td>
<td>67</td>
<td>14</td>
</tr>
<tr>
<td>November</td>
<td>72</td>
<td>15</td>
</tr>
<tr>
<td>December</td>
<td>53</td>
<td>10</td>
</tr>
<tr>
<td>January, 1932</td>
<td>64</td>
<td>19</td>
</tr>
<tr>
<td>February</td>
<td>68</td>
<td>2</td>
</tr>
<tr>
<td>March</td>
<td>62</td>
<td>2</td>
</tr>
<tr>
<td>April</td>
<td>58</td>
<td>1</td>
</tr>
<tr>
<td>May</td>
<td>69</td>
<td>8</td>
</tr>
<tr>
<td>June</td>
<td>62</td>
<td>6</td>
</tr>
<tr>
<td>July</td>
<td>80</td>
<td>1</td>
</tr>
<tr>
<td>August</td>
<td>71</td>
<td>8</td>
</tr>
<tr>
<td>TOTALS</td>
<td>821</td>
<td>168</td>
</tr>
</tbody>
</table>
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 albinus were dissected by the junior author during the period January to September, 1932 inclusive. Of these, 120 were from the control town, N'w San Juan, which did not receive plasmodin treatment. One of these was found infected, giving a rate of 0.83 per cent. From the other four towns under plasmodin 832 Anopheles albinus were dissected, and 4 infected individuals were found, giving a rate of 0.48 per cent, about half that of N'w San Juan. The numbers, however, are comparatively small, and a longer series should 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 plasmodin 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.**

<table>
<thead>
<tr>
<th></th>
<th>N. San Juan</th>
<th>Santa Rosa</th>
<th>Guayabalito</th>
<th>Gatun-cillo</th>
<th>Las Guacas</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan.</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Feb.</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>March</td>
<td>10</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>April</td>
<td>6</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>May</td>
<td>15</td>
<td>11</td>
<td>4</td>
<td></td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>June</td>
<td>11</td>
<td>10</td>
<td>52</td>
<td></td>
<td></td>
<td>73</td>
</tr>
<tr>
<td>July</td>
<td>14</td>
<td>43 (1 P)</td>
<td>105 (1 P)</td>
<td>17</td>
<td>8</td>
<td>187</td>
</tr>
<tr>
<td>August</td>
<td>24 (1 P)</td>
<td>46</td>
<td>59</td>
<td>33</td>
<td>138</td>
<td>309</td>
</tr>
<tr>
<td>Sept.</td>
<td>56</td>
<td>76 (1 P)</td>
<td>68 (1 P)</td>
<td>54</td>
<td>85</td>
<td>341</td>
</tr>
<tr>
<td>Total</td>
<td>120</td>
<td>209</td>
<td>288</td>
<td>104</td>
<td>231</td>
<td>952</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No. Pos.</th>
<th>1 P.</th>
<th>2 P.</th>
<th>2 P.</th>
<th></th>
<th>5 P.</th>
<th>0.52</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate</td>
<td>0.83</td>
<td>0.95</td>
<td>0.89</td>
<td></td>
<td>0.52</td>
<td></td>
</tr>
</tbody>
</table>

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 plasmodinum twice a week, one control village receiving no plasmodinum. 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 unsanitary 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 plasmodinum per week in addition to quinine sulphate, showed a malaria rate approximately equal to our five villages (17.5% and 16.3% 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 plasmodinum was twice that of the four villages in which it was administered. In spite of continued plasmodinum 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 plasmodinum under field conditions, where more rigid 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 plasmodinum to positives, only, as in the Madden Dam Highway area.

Among the employees at Madden Dam where quinine and plasmodinum 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 Ames 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 plasmoquine twice weekly for 12 months (four times the quantity we gave). The incidence of clinical malaria was reduced from 39.4 per cent in F-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.