## REPORT OF BUREAU OF MALARIA CONTROL

### 1926-27

### Part III

#### INCIDENCE OF MALARIA

Spleens were examined and blood smears obtained simultaneously in four hundred people of all ages in this region and blood smears from about six hundred more. Per cent of hemoglobin was determined in the majority by means of the Dare hemoglobinometer. That it was a region with considerable malaria was shown by the fact that the spleen rate was thirty-one and the parasite rate twenty-six. (Table VI.) One of the highest rates was found in Río Abajo the colony surrounded by the canefields drained by the pumps, where the spleen and parasite rates were sixty and forty-four, respectively. The large amount of acute illness in this region confirmed these findings.

#### COMPARISON OF SPLEEN AND PARASITE RATES

While the per cent of positives among all smears examined was only twenty-six it was somewhat higher (35) in the group in which spleens were also examined, apparently because of the relatively large number examined in the lower-age groups where the rates were higher. The spleen rates were more or less uniformly high from five to fifty years, the rates being lower in the very young and in the very old. (Table VII.) The parasite rates showed a much more definite peak in age groups, five to twenty, especially ten to twenty where they were much higher than the spleen rates. In adults the parasite rate tends to drop behind the spleen rate. In this region one-third of palpable spleens extended definitely below the costal margin, but none were below the umblicus.

Twenty-eight per cent of those with impalpable spleens showed parasites in the blood and fifty-one per cent of those with palpable spleens were found with parasites. However, seventy per cent of those with No. 5 spleens showed parasites. It is thus apparent that in this region at this time a palpable spleen especially of the larger size was good evidence of malaria infection, but that malaria infection may still be present in the absence of a palpable spleen. (Table VIII.)

Infection rates were also studied as much as possible from the year. A steam pump supplies the power. Since then the area drained by the pump has been increased until during 1925 and 1926 it was found that the one pump could not remove all the water when rains were heavy and at other times the canals did not deliver the water fast enough to the pumps when the quantity of water was moderate. A great deal of trouble was encountered with the steam engine, making frequent stops for repairs necessary. In spite of all difficulties, however, and the loss of considerable plant cane, it was shown that the soil which was drained sufficiently was very fertile and that a high yield of cane could be counted on. Consequently in 1926 the installation of a second pump run by an electric motor was begun. Before the work was completed, however, a cyclone passed over the Island and the accompanying rains and high waves flooded the lowlands causing a loss of several hundred acres of plant cane. At present the two 30-inch pumps are in operation and are available for emergency work. Rains in that region as in many others have been unusually heavy this year and even with the two pumps great difficulty has been encountered in removing the water soon enough from the young cane, but the difficulties seem to be due more to faulty construction of canals than to small capacity of pumps.

Until observations were begun in September 1926 it is obvious that the pumps had had very little effect upon the malaria in the colony Río Abajo, for at that time high spleen and parasite rates were found and a very large amount of acute cases. Undoubtedly early in the work the area drained by the pumps was so narrow that mosquitoes easily flew in from the undrained areas. Due to difficulties with the boilers the pumps themselves were not working efficiently, so that within the pump area, water was left stagnant for long periods and observations showed that breeding was taking place in many canals with much floating debris and especially near the termination of many canals where, of course, there was little flow of water. In the main ditches, however, even with some vegetation on the edges it is rare to find larvae in any numbers, the flow of water and raising and lowering of level apparently controlling breeding. Observations have been continued into all parts of the area drained by the pumps and it is rare to find many larvae in those ditches which are directly connected with the main canals, but there are several particularly low areas, the outlets of which are apparently inadequate and in which water is sufficiently stagnant to permit much breeding to take place. In these areas the growth of cane is also poor so that undoubtedly conditions will be greatly improved later on. Since the two pumps have been working, the catches of mosquitoes have been very low and the incidence of acute malaria has dropped off, but observations will be necessary through other seasons to draw definite conclusions. The region included in the pump area extends for a kilometer from the colony so that if very little breeding takes place in the cane fields there ought to be a definite reduction in malaria incidence. Even with the defects in the system already noted, larvae are much more difficult to find in the pump area than without and the increased production in cane has made the project worth while.

### OBSERVATIONS OF SCREENS AND SCREENING MATERIALS

Considerable screening is done in Porto Rico, especially in the houses of the important employees of the larger centrals. The general impression has been that even copper screens would not last much longer than a good grade galvanized wire and that it was not worth the additional expense. It was also stated by many that, even with screens, larger numbers of mosquitoes often get in and in most cases mosquito nets were being used at night in addition to the screens. Most Porto Ricans and many Americans resident here do not wish screens because of the feeling of being shut in and because they say that it makes the house hot.

Because of the proved value of screens in other countries and the great assistance that proper use would be in Porto Rico, most of these points have been investigated. Information upon the durability of various materials was obtained by observation of screens on the house in which the Chief of the Bureau lived at Fajardo, which was on the beach and exposed to the most severe conditions that are encountered there, and by placing samples of various screens along the porch exposed on the ocean side. The screen used on the house bore the mark of Wickwire Spencer Company and was called Hard Copper No. 16 mesh. Actual analysis of a sample in the Department of Health Laboratory showed the wire to be very pure copper. It was soon obvious that the test to which the screens were put on the house was much more severe than that of those on the porch, for two months after being placed due to pushing of children some of the screens began to tear out along the margin. But before the year was up, several screens had decomposed along the margin of attachment to the frame and in parts of the screens the wire was so thin that with very slight pressure it could be broken. The greatest trouble was encountered with those screens which were on the side away from the ocean and breeze, and which collected the dust and lint from the rooms during cleaning. Screens that were protected by curtains were almost as new at the end of the year as they were at the beginning. Copper screen on a crib, after two years use, is as new as ever. Apparently the dust held the moisture and when winds were strang the air was salt laden from the ocean so that rather rapid decomposition took place. It seemed to make little difference whether copper or iron were used as far as the life of the screen was concerned, though, of course, iron nails rusted out very quickly. There is thus ground for the contention that near the ocean here the life of the ordinary grades of copper screen may under certain conditions be very short. A sample of No. 18 mesh which is made as a rule with a slightly smaller wire, .01 or .009 inch, did not last as long as the No. 16. Frequent cleaning is necessary for which a fine wire brush seemed to give the best result.

On July 2, 1926, the following samples were placed in frames on the porch exposed to the ocean:

1. The New Jersey Wire Cloth Company, 16 mesh copper screen. .01-inch wire dark finish.
2. Same company and same mesh but with .015-inch wire.
3. American Wire Fabrics Company, Antique Bronze 16 mesh. .015-inch wire.
4. American Wire Fabrics Company, Antique Bronze 16 mesh. .01-inch wire.
5. American Wire Fabrics Company, Copper 16 mesh. .01-inch wire.
6. American Wire Fabrics Company, Monel metal 16 mesh, .009-inch wire.
7. Galvanized wire, 12 mesh, bought on the market in Porto Rico.
8. Andrew McLean and Company cloth screen.

Within eight months the cloth screen had rotted around the edges and was very easily torn. Before the year was up there was very little left of it. The galvanized screen had begun to rust at eight months but at the end of the year it was still strong. At the end of the year none of the others showed noticeable decomposition. All had become quite green in color except the monel metal though the color of the bronze was much less intense than that of the copper. It is obvious that to really test a screen one must put it to actual use unless more rigid tests can be developed. Thus, of the copper screens that were in actual use some had rotted out within eight months while others were still in use eighteen months after having been put on, though there is considerable evidence of decomposition.

Some rough tests were performed to try and determine the amount of obstruction to wind caused by the various screens. A fan and anemometer were placed on the same level on a long table in the laboratory and the velocity of the wind produced by the fans was determined. Then samples of the various screens were placed one at a time, between the two and the velocity of the wind determined for each. In another series of trials a set of wet and dry thermometers was substituted for the anemometer and the time necessary to lower the west-bulb thermometer to its minimum was determined, first with the fan alone and then with the various screens between the fan and the thermometers. It will be noted in Table XI that the results of the two sets of trials are not in entire agreement, but that with the anemometer the least obstruction was caused by the No. 12 mesh galvanized and then the monel metal. The greatest reduction was caused by the cloth screens. It is difficult to get the cloth screen stretched tightly and when wet it sags considerably and the spaces fill up with water so that practically no air pases through at all. The second series of trials showed, in agreement to the first, that the greatest obstruction was caused by the heavier grades of wire and by the cloth screen, but that in the others the temperature of the wet thermometer reached the low point as quickly with the screens in place as without any screen at all. These experiments were performed with the screen always at right angles to the direction of the breeze. It was noted that when it was put at any other angle there was no change in results noted in those which had produced the least obstruction at first, but with the cloth screen much more air apparently went, through, so that the apparatus registered a velocity more than twice as fast as it did when the sereen was at right angles.

It is apparent that screens offer considerable resistance to the wind, especially those with the heavier wire or made of cloth, but that those with finer wire reduce the velocity only about one-third. The movement of air was not reduced sufficiently, however, to show an appreciable difference in time of lowering of wet bulb of thermometer so that the effect upon human comfort probably it not so great as would be indicated by the velocity readings. Mosquito nets in most cases are much worse than the cloth screen, as far as obstructing the breeze is concerned, so that there is no consistency in objecting to screens because they keep out the breeze when mosquito nets are being used, which often are so heavy that one cannot even see through them.

Houses in Porto Rico are as a rule very difficult to screen because of the large number of doors and lattice windows, all of which open toward making it impossible to fix the screen on the outside permanently. If screens are put on with hinges they are invariably left open by the servants. The tendency in recent construction has been to build small compact houses, without large porches, houses such as are convenient for cold climates. They are hot even without screens. The matter is being studied to determine if a cheap comfortable house with screens can be made for labor colonies in regions where the population is scatterd and the incidence of malaria high.

It is essential to consider carefully the size of the wire used in the screen and as there are various systems of numbering, the only safe way is to specify the size of wire in parts of an inch. Naturally the finer the wire the less obstruction to the breeze, but in these regions I do not believe it is worth while to consider light grades of galvanized wire. It is very probable that a .015-inch galvanized wire will last as long as a .009 copper and that a 16-mesh would keep out as small an insect as an 18 mesh copper with the finer wire. In Porto Rico there is no indication for anything finer than No. 16, and in the heavier wire it is probable that a 14-mesh would do. The small biting flies seem to be able to pass through anything that air passes through. If one is going to buy copper or bronze the wire should have a diameter of at least .012 and better still, .015, especially for doors and windows which are exposed to heavy use. When the heavier wires of copper or bronze are being considered the cost approaches that of monel metal and recent quotations on screening with monel metal indicate that it can be obtained as cheaply or more so than the heavy grades of copper and bronze. The wire ordinarily used, however, is .099-inch and when used on doors would certainly need considerable protection. All reports seem to indicate that monel metal will outlast copper and bronze and that for long life near the ocean, where screens are in use the year round, it is probably the metal of choice. Again, the size of wire and its quality must be taken into consideration. Where one wants only temporary screening as in a summer home or where one expects to move often, I believe that a heavy galvanized wire will be found to be about as economical as any. Our experience with screens versus mosquito nets makes us entirely in favor of the screens.

TABLE VI

**SPLEEN AND BLOOD INDEXES—HUMACAO BY DISTRICTS**

| | Playa | | | Palm Grove | | | Río Abajo | | | Pasto Viejo | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. | Pos. | Per Cent | No. | Pos. | Per Cent | No. | Pos. | Per Cent | No. | Pos. | Per Cent | No. | Pos. | Per Cent |
| Spleen .... | 344 | 110 | 32 | 24 | 5 | 20 | 25 | 15 | 60 | 3 | ... | .. | 403 | 127 | 31 |
| Blood .... | 800 | 192 | 24 | 101 | 21 | 22 | 92 | 41 | 40 | 18 | 10 | 55 | 101 | 264 | 26 |

TABLE VII

**SPLEEN AND BLOOD INDEXES—HUMACAO BY AGE GROUPS**

**Blood and Spleen Examinations in Same Individuals**

| | -1 | | | 1-4 | | | 5-9 | | | 10-14 | | | 15-19 | | | 20-49 | | | 50 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. | Pos | Per Cent | No. | Pos | Per Cent | No. | Pos | Per Cent | No. | Pos | Per Cent | No. | Pos | Per Cent | No. | Pos | Per Cent | No. | Pos | Per Cent |
| SPLEEN ...... | 2 | ... | ... | 16 | 2 | 13 | 96 | 32 | 33 | 129 | 42 | 33 | 34 | 9 | 26 | 111 | 39 | 35 | 16 | 3 | 19 |
| BLOOD ...... | 2 | 1 | 50 | 15 | 5 | 33 | 96 | 29 | 30 | 129 | 59 | 46 | 34 | 15 | 44 | 111 | 28 | 25 | 16 | 4 | 25 |

TABLE VIII

**SPLEEN AND BLOOD EXAMINATIONS ACCORDING TO SIZE OF SPLEEN, SPECIES OF PARASITES AND RACE**

| Spleen Blood | 0 | | | 1 | | | 2 | | | 3 | | | 4 | | | 5 | | | Total Positive | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | T | P | Per Cent | T | P | Per Cent | T | P | Per Cent | T | P | Per Cent | T | P | Per Cent | T | P | Per Cent | T | P | Per Cent |
| White... | 103 | 30 | 29 | 16 | 5 | 31 | 11 | 5 | 45 | 9 | 3 | 33 | 4 | 2 | 50 | ... | ... | 40 | 40 | 15 | 37 |
| Black... | 31 | 12 | 39 | 6 | 6 | 100 | 3 | 1 | 33 | 1 | ... | ... | ... | ... | .. | ... | ... | 10 | 10 | 7 | 70 |
| Mulatto. | 142 | 35 | 25 | 23 | 7 | 30 | 21 | 13 | 62 | 12 | 7 | 58 | 11 | 8 | 73 | 10 | 7 | 77 | 77 | 42 | 55 |
| Total . | 276 | 77 | 28 | 45 | 18 | 40 | 35 | 18 | 54 | 22 | 10 | 45½ | 15 | 10 | 66 | 10 | 7 | 127 | 127 | 64 | 51 |
| Viv ...... | ... | 25 | 9 | ... | 9 | 20 | ... | 8 | 23 | ... | 1 | 4½ | ... | 2 | 13 | ... | ... | ... | ... | 20 | 16 |
| Fal ...... | ... | 52 | 19 | .. | 9 | 20 | ... | 11 | 31 | ... | 9 | 41 | .. | 8 | 53 | ... | 7 | ... | ... | 44 | 35 |

TABLE IX

**AVERAGE PER CENT OF HEMOGLOBIN, BY RACE AND AGE**

| | 1 | | 1-4 | | 5-9 | | 10-14 | | 15-19 | | 20-49 | | 50 | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. | Av. Hb. | No. | Av Hb. | No | Av. Hb | No. | Av. Hb. | No. | Av. Hb. | No. | Av. Hb. | No. | Av. Hb. | No | Av. Hb. |
| White | 10 | 64 | 21 | 58 | 41 | 57 | 43 | 56 | 26 | 64 | 121 | 66 | 19 | 66 | 281 | 62 |
| Black | 1 | 42 | 6 | 64 | 6 | 54 | 10 | 49 | 9 | 59 | 41 | 65 | 16 | 61 | 89 | 61 |
| Mulatto | 11 | 53 | 59 | 53 | 69 | 53 | 75 | 56 | 39 | 60 | 135 | 62 | 29 | 58 | 417 | 58 |
| Total | 22 | 58 | 86 | 56 | 116 | 55 | 128 | 56 | 74 | 61 | 297 | 64 | 64 | 61 | 787 | 59 |

TABLE X

**AVERAGE PER CENT OF HEMOGLOBIN ACCORDING TO SIZE OF SPLEEN AND SPECIES OF PARASITES**

| Spleen Blood | 0 | | 1 | | 2 | | 3 | | 4 | | 5 | | Total Pos. | | Total Neg. Pos. | Total Spl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. | Av. Hb. | No. | Av. Hb | No. | Av. Hb. | No. | Av. Hb. | No. | Av. Hb. | No. | Av. Hb. | No. | Av. Hb. | No | Av. Hb. |
| Negative | 177 | 59 | 23 | 58 | 13 | 61 | 10 | 51 | 3 | 48 | 3 | 47 | 52 | 56 | 229 | 59 |
| Vivax | 20 | 56 | 8 | 54 | 6 | 56 | 1 | 47 | 1 | 46 | ... | ... | 16 | 54 | 36 | 55 |
| Falciparum | 47 | 52 | 7 | 55 | 10 | 55 | 7 | 53 | 7 | 48 | 6 | 46 | 37 | 42 | 84 | 52 |
| Total | 244 | 58 | 38 | 56 | 29 | 58 | 13 | 52 | 11 | 48 | 9 | 47 | 105 | 55 | 349 | 57 |

TABLE XI

**DATA ON OBSTRUCTION TO WIND CAUSED BY VARIOUS TYPES OF SCREENS USING ELECTRIC FAN AS SOURCE OF WIND**

| | With out screen | 1 16 Mesh copper in .01 wire | 2 16 Mesh copper .015 in wire | 3 16 Mesh bronze .015 in wire | 4 16 Mesh bronze .01 in wire | 5 16 Mesh copper .01 in wire | 6 16 Mesh monel metal .009 | 7 12 Mesh Galv. wire | 8 Cotton cloth screen 16 Mesh |
|---|---|---|---|---|---|---|---|---|---|
| (1) Screen at right angle to direction of wind | 10 | 6 | 5 | 5.5 | 6 | 6.5 | 7.0 | 8.5 | 2.5 |
| Screen at 45° angle | ... | .... | 6.5 | 6.5 | 6 | 6.5 | 7.0 | 8.5 | 6.5 |
| 2 Screen at right angle to direction of wind | 35 | 35 | 52 | 48 | 35 | 35 | 38 | 40 | 60 |
| Screen at 45° angle | .... | 35 | 45 | ... | ... | ... | ... | .... | 40 |

(1)------------------------------------------------with Anemometer
2--------------------------------------------------with Thermometer

1. Numbers represent velocity of wind in miles per hour.

2. Numbers represent time in seconds necessary to reduce temperature of wet bulb to minimum.

Dry temperature at beginning, 85. Wet = 78.5.

Dry temperature at end of experiments, 87.5. Wet = 78.8.