

## MALARIA CONTROL IN GUAYARAMERIN, BOLIVIA<sup>1</sup>

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At the beginning of 1943, as part of a cooperative health program between the governments of the United States and Bolivia, the Health and Sanitation Division of the Institute of Inter-American Affairs began a malaria control project in Guayaramerin.

Guayaramerin is located across the Mamore River from the terminus of the Madera-Mamore Railroad on the Bolivian-Brazilian frontier. With a population of 1,300, it is an important frontier town and a center of rubber development. Located in the equatorial lowlands its climate is hot and humid. Guayaramerin may be reached by air, from east or west; by rail from Porto Velho, Brazil; and by water through Brazil or Bolivia. Transportation by air is costly, by rail or river launch it is slow and difficult.

Original investigations in Guayaramerin revealed a high endemicity of malaria. The parasite rate for children under twelve years of age ranged between 17 per cent and 20 per cent; the splenic index was 85 per cent. The actual malaria vector is still a matter for conjecture. However, Anopheline mosquitoes of the following species have been collected: *A. darlingi* Root, *A. triannulatus*

(N.&P.), *A. oswaldoi* (Perry), *A. rondoni* (N.&P.), *A. mediopunctatus* (Theob.), and *A. albitarsis* Lynch Arrib. Identification of all specimens mentioned in this paper was made by Dr. Alan Stone of the U. S. National Museum.

The average adult Anopheline mosquito density per house was four. No records are available for the larval density before 1946. Early control operations consisted of leveling the unpaved dirt streets of the town, putting in drainage ditches and using paris green as a larvicide on temporary bodies of water. At the same time, atabrine was distributed free to the entire population. While these methods were partially effective, a fifty per cent morbidity, most of which was probably due to malaria, pointed to the need for additional control measures.

The use of paris green was continued and more extensive drainage work was undertaken. The campaign for the atabrine suppression of malaria in the population was intensified. A dosage of three yellow atabrine pills per week kept the rubber sap gatherers in the tropical rain forests and the town's people at their daily occupations. However, there were continued relapses because the population never became educated to the necessity of the routine use of atabrine as a suppressive.

These methods were continued during the years 1943, 1944, and 1945 and construction of a modern hospital was completed (Fig. 1). Nevertheless, the end of the year 1945 saw no substantial reduction in morbidity due to malaria.

It was about this time that the new product, DDT, became available for use in the field. In May 1946, for the first time in Bolivia, DDT was applied in the

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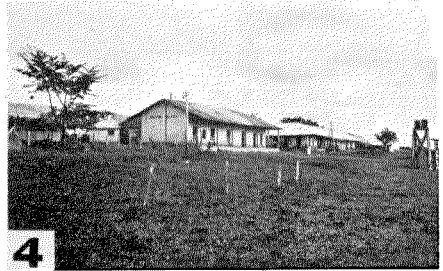
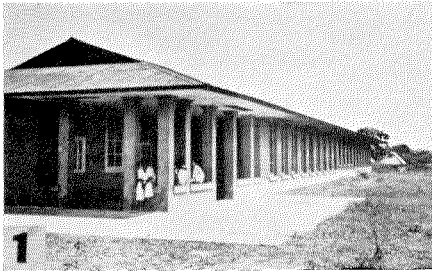


FIG. 1. Guayaramerin Hospital. Completed in 1945. A modern building of brick and concrete.  
 FIG. 2. First house in Guayaramerin to receive DDT residual spray treatment.  
 FIG. 3. Typical Guayaramerin house. Adobe, with straw thatch.  
 FIG. 4. A modern Guayaramerin building. The Royal Hotel.

treatment of an entire town, i.e. Guayaramerin. The buildings there are of various designs and constructions. There are houses of split bamboo with grass and palm thatched roofs some of which are plastered with mud and whitewashed inside and outside. There are also buildings of adobe and some houses of modern construction (Figs. 2, 3, 4):

Oil soluble DDT was used in the first treatment of Guayaramerin for these reasons: availability, more knowledge by those concerned in the use of oil soluble than water dispersible DDT at that time, and the fact that a supply of surplus fuel oil was then available in Guayaramerin. Operations began on May 4, 1946. Wall surfaces totaling 64,528 square meters in 203 houses, were treated at an average cost of 2.5 cents per square meter and approximately \$8.20 per house. These cost fig-

ures include air freight for all materials, air passage for all personnel, and the price of \$1.00 per pound for DDT and 50 cents per gallon for fuel oil. A residual of 1.63 grams per square meter remained. Of the 203 houses which were treated, 50 had been chosen for inspections before and after treatment. Inspections of fifteen minutes duration per house was made at six thirty P.M. the evening preceding treatment and again one week later. The original inspections netted two hundred adult mosquitoes, an average of four per house. The post treatment inspections netted only sixteen mosquitoes.

Practical spraying apparatus for field use was evolved using nozzles from New Idea Knapsack Sprayers and tanks and hose of Aeroil Burners (Fig. 5). The optimum spraying effect was secured with 30-35 pounds pressure in the tank and

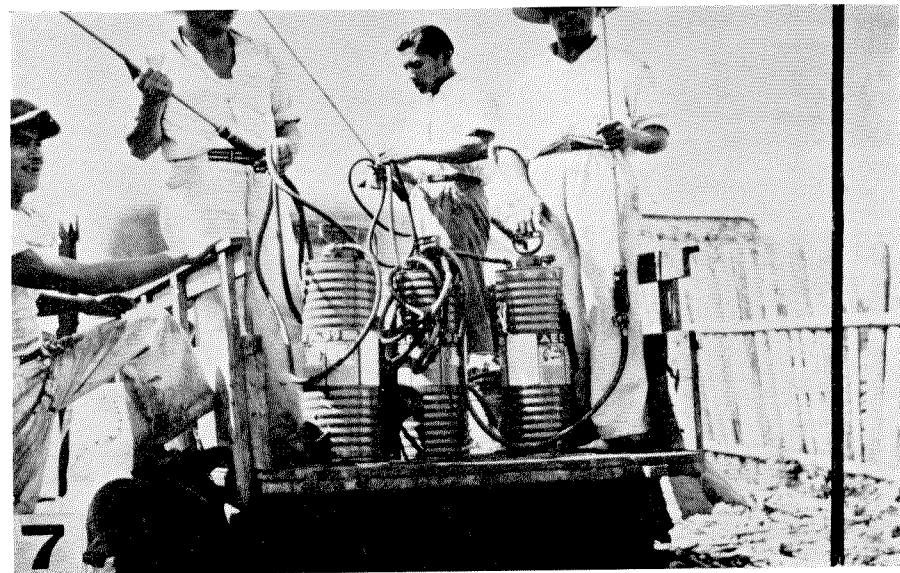
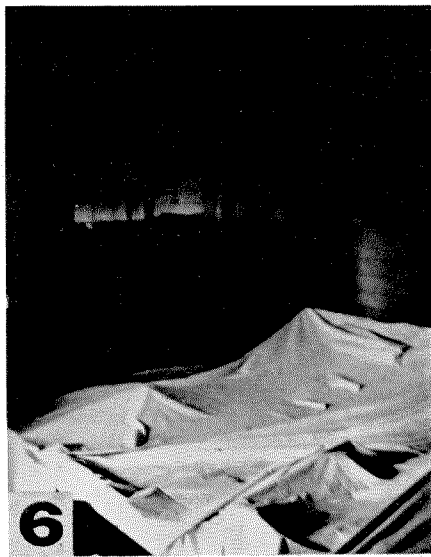


FIG. 5. Dr. Saracho Lopez, hatless, helping to mix and pour first DDT solution into aeroil tank.  
FIG. 6. House furniture covered with sheets to prevent spotting with oil.  
FIG. 7. Spray crew and equipment.

the use of the smallest aperture of the nozzle held about eighteen inches from the wall. A fan-shaped spray of fine particles of oil was applied to the wall, from floor to ceiling, then from ceiling to floor by continuous vertical motions in even adjoining swaths. For painting screens standard three inch paint brushes and buckets filled with the spraying solution were used.

Seven ounces of 100 per cent DDT powder per gallon of oil gave the 5 per cent solution which was used for spraying operations. After removing three gallons from a 53 gallon drum of No. 2 Diesel oil (fuel oil) 22 pounds of DDT powder were added. With the solution from the drum the sprayer tanks were two-thirds filled, leaving the remaining space for air pressure.

The personnel for the spraying operations included one foreman and two spray crews. Each crew was composed of four men (Fig. 7). Two men operated the hand sprayer, one man handling the hose and nozzle, the other managing the sprayer pump. The number three men were detailed to advise the occupants of the proximal house of the approaching crews and to help prepare the house for spraying operations (Fig. 6). The number four men followed with an additional sprayer to exchange for the emptied one. Spray crews were taught by example and actual practice to apply the spray at the rate of approximately 30 square meters per minute. Turns were taken in these duties and changes were frequently made in order not to burden any one man with too long a period at the most difficult job. The handling of the spray nozzle was considered by the laborers to be the most difficult and tiring work. No allergic reactions or other ill effects were observed among the crews as a result of handling or being exposed to DDT oil solution.

From house to house, and from room to room, the personnel of the malaria control organization effected these measures. This use of DDT produced quick, positive results. There were fewer adult mos-

quitoes in the houses; there were fewer people ill from malaria. Plans were immediately made for repeating the treatment at six month intervals.

In the meantime, water soluble DDT had become available and was used in all subsequent operations in Guayaramerin. The second treatment took place between September 30 and October 11, 1946. 206 houses were treated involving a total wall surface area of 68,371 square meters, leaving an average residue of 4.33 grams per square meter. At a price of 50 cents per pound for water soluble DDT in Bolivia, the cost per square meter was 1.5 cents, averaging \$4.85 per house. Houses inspected prior to this treatment had revealed a grand total of 3 adult mosquitoes.

Anticipatory inspection of scattered houses prior to the May 1947 treatment revealed few adult mosquitoes. Selection was then made of 46 houses on the periphery of the town close to the natural breeding places of the mosquitoes. This inspection netted 94 adult mosquitoes, an average of two per house.

160 houses were treated with water soluble DDT. The total wall surface covered was 42,308 square meters. A residual of 4.35 grams per square meter remained. This operation cost \$2.90 per house. The noticeable reduction in expenses was due to the fact that the entire labor force for this operation was furnished gratis to the project by the Mayor's office and the military detachment.

The beneficial results of this program were so dramatic and self evident that no special educational campaign was necessary. The offer of free labor by the Mayor's office and the military detachment were evidences of the good will engendered. The people of the town were cooperative. They were interested from the first in having the program made a regular public health service.

June and July 1947 inspections of 50 houses each month revealed no adult Anopheline mosquitoes. The August inspection of 150 houses resulted in the capture of 21 adult Anopheline mosquitoes.

Inspections in September, October and November 1947 of 50 houses per month again revealed not a single adult Anopheline mosquito. Because of these results the routine October DDT residual treatment of houses has been postponed deliberately for an indefinite period or until inspections reveal the presence of adult Anophelines, necessitating additional DDT applications.

Since the initial DDT application in May 1946 there has been no epidemic of malaria in Guayaramerin. The number of cases at any given time has not exceeded 10 with the exception of the month of August 1947 when 29 malaria patients were treated in the Guayaramerin hospital. However, of this number more than half were not native residents.

Since the records of larval density became available they have revealed an average of 10 larvae per dip. This number fluctuates according to the seasons, the largest number of larvae being present between the wet and dry seasons.

The treatment of houses with DDT during the past two years has had no noticeable effect on larval density in natural breeding places surrounding Guayaramerin. This fact has revealed the necessity for the use of a larvicide. Preliminary trials with water soluble DDT in concentrations of 3, 5, 10 and 15 per cent showed that it precipitated out of solution when used on natural breeding places. Oil soluble DDT of equal concentrations

has proved to be more effective as a larvicide.

Future malaria control operations in Guayaramerin will consist solely of the application of oil soluble DDT as a larvicide. This will be applied to all natural breeding places for an area of one mile around the periphery of the town. This procedure will decrease considerably the cost of malaria control and simplify the operations. It will eliminate the necessity for the presence of professional personnel after the training of local workers.

#### SUMMARY

The history of Malaria control in Guayaramerin, Bolivia since 1943 is traced. The preliminary measures used and the later treatments with DDT are described. The future malaria control program will consist of the use of oil soluble DDT as a larvicide.

#### RESÚMEN

Se trata de la historia del control antipaludico en Guayaramerin, Bolivia desde el año 1943. Se describen los métodos introductorios y los tratamientos subsecuentes con el DDT. El control antipaludico del futuro usará el DDT soluble en aceite como larvicide.

#### Bibliography

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