

Malaria Control in the Dominican Republic¹

By MAJOR JAMES D. CALDWELL, A. U. S.

From the Institute of Inter-American Affairs in the Dominican Republic

THE DOMINICAN REPUBLIC occupies approximately two thirds of the West Indian island that Columbus originally called "Hispaniola," following his discovery of America. It is situated between Cuba and Puerto Rico and is the second largest island of this West Indies group. For the most part, the Dominican Republic is high-lying, with very little coastal plain. Beginning at sea level, rolling country gradually gives way to hills and mountains as the interior of the island is approached. The one exception is the Lake Enriquillo Basin in the southwestern portion, one hundred and fifty-four feet below sea level at the water surface of the lake.

There are three distinct mountain ranges lying in a northwest to southeast plain; their highest peak is approximately 11,000 feet. Drainage from the area north of the central mountain range empties into the Atlantic Ocean and that from the southern slopes, into the Caribbean. Generally speaking, drainage is good. Swamps, fresh water lakes, and lagoons are few, small in size, and scattered.

The mild tropical climate found in the Dominican Republic is much the same as that in the neighboring islands. Likewise, the occurrence of malaria is similar.² This disease presents a problem in almost every section of the Republic, hence it is commonly referred to as the No. 1 public health problem even though sufficient data are not available to substantiate this opinion. Nonetheless, its importance from the standpoints of public health and economy must be recognized. Malaria is present throughout the country, but its prevalence varies considerably between communities.

Rainfall is plentiful in most sections, the exception being the arid desert country in the southwest and northwest where yearly precipitation ranges from 16 to 25 inches. However, the rest of the country receives an abundant supply, some parts boasting a yearly precipitation of over 100 inches. As is typical of the Caribbean region, the rainy season usually lasts from May to October; the heaviest rains occur in the spring and fall. Generally, there is a

1. Received for publication March 15, 1945. Paper prepared for delivery at the Fourth Annual Meeting of the Puerto Rico Public Health Association, February 14, 1945.

2. A Symposium on Human Malaria, Pub. No. 15 of the American Association for the Advancement of Science. Edited by F. R. Moulton (Lancaster, Penn.: The Science Press Publishing Company, 1941).

definite relation between rainfall and malaria incidence, the number of cases increasing during the periods of heaviest rainfall.

In most communities, breeding places of malaria vectors are confined to streams, but swamps are found in or near a few of the coastal towns. Fresh water lagoons, which have in all probability been formed by geological changes in the earth's surface, are responsible for breeding in a few areas. In recent years, crop irrigation has become an important problem and at present, irrigated fields seem to be the principal source of trouble. An agricultural program to develop irrigation tracts is creating increased numbers of such areas and greatly aggravating the malaria problem, but sufficient legislation is lacking whereby intermittent flooding and other control measures might be required. A few towns do have ordinances regulating irrigation practice as a means of malaria control.

These ordinances establish a "zona de protección anti-palúdica," which is the area lying two kilometers distant from the outer limits of the community. Control measures including intermittent flooding, limited storage periods for irrigation water, and suitable drainage arrangements are prescribed for fields within this protected zone. The "Síndico Municipal" is responsible for issuance of permits and is also charged with the enforcement of the ordinance.

Although the Dominican Republic boasts a health service of twenty-six years duration, its Malaria Division was not established until 1941. Since that time, small appropriations have provided limited facilities for permanent and temporary control measures and for a partially equipped laboratory that handles blood and entomological specimens. The activities of this Division have been restricted to a very small radius as a result of limited funds, lack of sufficient personnel, and transportation difficulties. Permanent drainage construction by the Division has been undertaken in one community and, in this specific instance, is credited with having effected a very wholesome reduction in the malaria rate.

Through the facilities of the Health Division, known as the "Campaña Sanitaria," antimalarial drugs are dispensed throughout the Republic to clinically diagnosed cases. Most of the drugs are used for curative purposes rather than for prophylaxis. The cost of these drugs to the Department is considerable and, even then, it is claimed that the needs have been greater than the supply. Doubtless, the use of antimalarial drugs has tended to suppress the incidence of the disease and has probably interfered, furthermore, with case finding by blood surveys.³

3. Informes Anuales de la División de Malariología, República Dominicana, 1941, 1942, 1943, 1944.

In August, 1933, the Institute of Inter-American Affairs, through its Executive Vice-President, Major General George C. Dunham, executed an agreement with the Dominican Republic whereby a cooperative health program was to be undertaken under the sponsorship of the two governments. Accordingly, an allotment of funds, which was supplemented by a contribution from the Dominican Government, was made available by the Institute of Inter-American Affairs. The cooperative health organization created thereafter is known as the "Servicio Cooperativo Interamericano de Salud Pública" and, for the sake of brevity, is commonly referred to as the "Servicio," which name will be used throughout the rest of this paper. A subsequent agreement between these two governments was executed in February, 1944, making additional funds available from both governments and thereby expanding the program and extending its period of operation.

The Dominican Republic is one of eighteen Latin-American countries in which this type of cooperative service is being operated. The new schedule calls for operation through the year 1947; health projects are being formulated accordingly. Though the second basic agreement stated that "Servicio" funds might be used principally for malaria control purposes, it did not prohibit the operation of other types of health projects.

"SERVICIO" DRAINAGE PROJECTS

Malaria control drainage projects have already been undertaken in three communities of the Republic: San Cristóbal, with a population of about 5,000, Villa Duarte, a section of Ciudad Trujillo, population about 10,000, and Monseñor Nouel, population about 4,000. Each project is briefly described below.

The Malaria Division of the National Health Department, with the assistance of technicians from the Pan American Sanitary Bureau, provided paved drainage channels for several small streams in San Cristóbal. The work was begun in May, 1941, and continued until December, 1943, during which period of time approximately 1,900 meters of channel were constructed by small crews of laborers. Panama-type inverts with masonry side walls formed the type of construction. Commencing on December 16, 1943, the "Servicio" continued the work started by the Malaria Division and extended the drainage system by 2,018 meters of paved channel. Of that distance, 1,080 meters of distance was paved with precast inverts and masonry side walls. The remaining distance was paved with

precast inverts and slabs. Slab dimensions are approximately 14" x 30" x 2" with male and female joints.

The total cost of that project was \$15,498.97, not including certain services and equipment made available by the Dominican Government.

As all minor drainage work needed in San Cristóbal was not included in the project described above, a supplementary project was undertaken during September, 1944, for the purpose of completing the permanent drainage improvements. That work is now in progress and is due for completion in March, 1945, completing an additional distance of paved drainage of approximately 1,100 meters. An open-earth channel, 400 meters in length, is to be constructed also. The anopheles breeding places now remaining are restricted to a flat river, with a gravel bed, which changes its course frequently thus precluding the possibility of permanent control measures. It is proposed to combat this seasonal problem with the use of larvicides.

Permanent drainage construction was started in Villa Duarte, a section of Ciudad Trujillo, in August, 1944. This project is also due for completion early in March, 1945. Four different areas were included in the Villa Duarte project, which involved both channel construction and filling of low areas. In one flat area along the east bank of the harbor of Ciudad Trujillo, one large lagoon and several smaller pools were eliminated by grading the sandy river bank between the water's edge and a steep bluff about one to two hundred meters distant. Approximately 5,000 cubic meters of earth were moved in that operation, all taken away by wheelbarrows.

The second area, also adjacent to the harbor, involved a swampy area, which was filled with 2,400 meters of material, and the construction of a channel approximately 525 meters in length. The third was quite similar to the second but larger, requiring more than 8,000 cubic meters of filling material. The total length of paved channel is approximately 400 meters.

Work in the fourth area consisted of placing precast inverts along highway ditches for improved roadside drainage. The total distance of such drains is 440 meters. These drains were placed largely for demonstration purposes in order to show officials of the Public Works Department how inverts may be used along streets and roads where no curb and gutter is provided. The estimated cost of the entire project is \$18,280.00.

The third town in which drainage improvements have been undertaken is Monseñor Nouel, the estimated cost of the project in this community being approximately \$32,000.00. This work has just

been started and will involve the construction of 5,875 meters of paved channel. The malaria incidence in Monseñor Nouel is very high; the number of cases increase considerably each year during the rainy season. In November, 1944, a blood and spleen survey was made; 38 percent of the smears were positive and 17½ percent of the spleens indicated malaria.

In addition to the drainage work being undertaken, another condition that greatly aggravates the malaria problem is being studied. This condition is due to the continual shifting of the course of the Yuna River and results in the flooding of a large area, adjacent to the town, by a portion of the river's flow which passes through a relief channel with insufficient cross-section and insufficient drainage structures to carry it. The Department of Public Works has been requested to construct a retaining wall, or dam, to restrain the river within its normal course.

It has been customary to establish shops for precasting inverts and slabs in the town in which drainage construction is under way. In selecting a site for the shop, an attempt is made to satisfy office and warehouse needs at the same location. It is considered more economical to haul cement and other materials to the site of the invert shop than to haul precast sections from one town to another. In most instances, sand and gravel are available locally, in which case only cement, tools, and forms need to be transported. Both invert and slab forms are portable and can be easily moved from place to place.

Following the completion of permanent drainage projects in a community by the "Servicio," maintenance of channels becomes a responsibility of the Malaria Division. However, "Servicio" engineers prepare maintenance schedules that are placed in operation after projects are formally turned over to this last named division.

MALARIA INVESTIGATIONS⁴

The principal malaria vector in the Dominican Republic is *Anopheles albimanus*, found in all sections of the country. Other species, which have been collected, are *Anopheles grabhamii* and *Anopheles vestitipennis*. *A. grabhamii* is quite common, being usually found in shaded streams. *A. vestitipennis* is less frequently encountered, but specimens have been collected in swampy places covered by deep shade (identification by Blatman, 1944). In a bulletin of the Na-

4. *Ibid.*

tional Institute of Health,⁵ Komp reported that *A. crucians* has also been found both in the Dominican Republic and in Haiti, but he does not state in what year. Technicians of the Malaria Division suspected one recent specimen as being *A. crucians*, but a definite identification was unfortunately not made. Obviously, the number of anopheline species present is small, so it may be definitely stated that *A. albimanus* presents the greatest problem from the standpoint of malaria transmission.

Prior to the establishment of the Malaria Division in 1941, comparatively little study had been made of the malaria problem. There is nothing in the literature to indicate any concerted efforts in this direction. During the years 1941 to 1943, laboratory facilities for handling blood smears were made available and several blood surveys conducted. Entomological surveys were also made, but these were mostly confined to sections where large numbers of clinical cases were occurring. In March, 1944, the "Servicio" set up a project for handling malaria investigations. Early surveys were supervised by an entomologist of the Institute of Inter-American Affairs, who assisted in training technicians and in the establishment of a system of field and laboratory operations.

Surveys have been made by communities and, in each case, have included preparation of maps showing the general topography, drainage courses, breeding areas, and so forth, of each section; blood smears and spleen examinations of samples of the population; searches for anopheline larvae; assembling of all available malaria morbidity and mortality statistics; and compilation of rainfall and other pertinent data. While the personnel of the survey group fluctuates to some extent, it usually consists of two to three medical officers, one engineer, and three or more medical technicians. Frequently, other survey personnel is drawn from the "Servicio" engineering section for specific tasks.

Field visits usually consume one week and that following, is spent in the laboratory on staining and microscopic examination of slides, examination of entomological specimens, and preparation of maps and reports. In this way, each of the personnel has the opportunity to participate in both field and laboratory work. To facilitate laboratory operations, the "Servicio" has provided a considerable number of laboratory improvements, including microscopes, supplies, furniture, fixtures, and other needed materials.

5. The Anopheline Mosquitoes of the Caribbean Region, Bul. No. 179, National Institute of Health (Washington, D. C.: U. S. Government Printing Office, 1942).

These improvements have greatly increased the capacity for handling specimens, and a better organization has resulted.

Mosquito traps of the stable-type have been constructed and placed in operation in several communities, regular collections being made in order to determine the anopheline density. Burros are used as bait. Most of these traps are operated four times weekly, but in some places, daily collections are made. The traps being used are of the McGoon type; instead of having only one central band for the entry of mosquitoes, two band slots have been provided. The openings are located at elevations of one foot and three feet above the trap base.

Complete malaria surveys were made during 1944 in thirty-one communities. The total number of blood and spleen surveys was thirty-six. Of this group, the percentage of positive blood smears ranged from 0.8 to 38.0 percent, the median being 7 percent. The percentage positive of all smears collected was 10.1. Spleen surveys by communities indicated rates ranging from 0 to 42.8 percent, with a median of 6 percent. The percentage of positive spleens found in all examinations was 8.1. All sections of the country are represented in the thirty-one communities in which surveys were made.

During 1944 a total of 13,546 blood specimens were examined in the laboratory. The number of spleen examinations made in the field was 7,550. Of a total of 1,374 positive blood smears, 72.8 percent showed *Plasmodium falciparum*, 17.18 percent showed *Plasmodium vivax*, 4.73 percent, *Plasmodium malariae*, and 5.61 percent showed mixed strains.

OTHER ANTIMALARIAL MEASURES

A larvicidal project is to be placed in operation soon, the organization, schedule arrangement, and training of personnel to be handled by the "Servicio." This plan calls for the operation of a larvicidal program in a selected community for a period of three months, its management to be later turned over to the Malaria Division for continuation. Larvicidal measures will be restricted principally to towns in which permanent control measures have been completed and in communities where malaria epidemics occur.

A recently established health education project is to be used to inform the public with regard to the mode of transmission of malaria and possible control measures. Some of this material has already been released.⁶

6. J. D. Caldwell, Activities of the "Servicio Cooperativo Interamericano de Salud Pública" in the Dominican Republic, October 1, 1943 to June 30, 1944; Informe del Servicio Cooperativo Interamericano de Salud Pública. Año 1944.

SUMMARY AND CONCLUSIONS

A public health program on a nation-wide basis has existed in the Dominican Republic for more than a quarter century, during which time the National Health Department has functioned continuously. Just as in many other countries of this region, the public health program was general in scope during many of its early years, and specialized services were largely lacking from its organization structure. In more recent years, technical divisions have been created for the purpose of pursuing problems in specialized fields. An example of this is the Malaria Division, established in the National Health Department in 1941.

During the four years of its existence, this Division has proved its right to a place in the governmental structure. Technicians have been trained and facilities have been established for the purpose of studying and combatting malaria. Early efforts to effect malaria control have already shown that results and prospects are bright for future program expansion.

In coöperation with the Institute of Inter-American Affairs, the Dominican Government has created a coöperative health agency known as the "Servicio Cooperativo Interamericano de Salud Pública," to which funds have been made available for program operation through 1947. The "Servicio" has undertaken several malaria control drainage projects and a project for malaria investigations. A project for larvicidal control of malaria and another to provide health education facilities will support the control measures now in operation.

The malaria problem in the Dominican Republic is similar to that of other islands of the Caribbean. The number of the species of anopheline mosquitoes found is small; *A. albimanus* is the principal vector. Entomological studies are included in the malaria surveys.

The principal source of breeding is streams, but swamps, lagoons, and irrigated fields are also responsible for anopheline production. Malaria is prevalent throughout the island and constitutes one of the most important public health problems. Rates vary considerably from one community to another, but no community is entirely free of the disease.