OBSERVATIONS ON MOSQUITO AND MALARIA CONTROL IN THE CARIBBEAN AREA

PART I—SURINAME [1]

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An opportunity to visit several entomologists and malarialogists representing mosquito and malaria control organizations was presented the senior author in March and April of 1946. The observations reported here were made in the course of extensive tests on the effectiveness of water-dispersible DDT residual sprays as a mosquito-control agent in the jungle of Surinam at Moengo.

The climate of Surinam is typical of low-lying coastal areas of the Tropics. The temperature averages about 81° F., with a range of only 14°. The heat is relieved somewhat by the trade wind, which blows almost constantly from the sea southwestward. The relative humidity averages about 84 per cent. There are four fairly well-defined seasons based on rainfall, which averages about 92 inches annually. The big rainy season lasts from March till August with an average of 10 inches of rainfall monthly, the big dry season from September until November with a monthly rainfall of about 4 inches. In December the rains begin again and they last through January, when it dries up until March.

Surinam, or Dutch Guiana, has a registered population of about 175,000, a third of which live in the capital, Paramaribo. One of the surprises greeting most visitors to Surinam is the number of nationalities represented. The true aborigines are the Indians who live mostly in temporary villages in the higher and drier bush. The Bush Negroes are pure descendants of the African black slaves who escaped from the plantations and settled along the upper rivers. The Surinamers, sometimes called creoles, a more or less mixed race, are descendants of the slaves brought to Surinam 200 to 300 years ago, Portuguese and German-Jews, and early Dutch settlers. Asiatics from India, China, and Java have been brought in as laborers. Western Europeans, largely Dutch, are also well represented.

Agriculture in Surinam is somewhat conducive to mosquito breeding. The hand-worked rice fields are prolific breeding places of *Anopheles aquasalis* Curry, *A. oswaldoi* Peryassu, and other species

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(Fig. 2). Relatively small areas of fallow-flooded cane fields also support an anopheline population, although, fortunately, they do not breed *A. darlingi* as do the comparable cane fields only a few hundred miles westward in British Guiana. Most fields and plantations are ditched to provide drainage during the wet seasons. These ditches, or trenches as they are called, also support large and varied populations of mosquitoes.

There have been greater and lesser epidemics of malaria in Surinam, but the disease furnishes a constant threat to any who may venture into some parts of the savannahs and in the bush of the interior (Fig. 1). There is little malaria around Paramaribo and the coastal area except in occasional localities.

Filariasis is seen commonly on the streets of Paramaribo among the Surinamers. It does not seem to occur among the Bush Negroes and Indians of the savannah and bush areas, no doubt because of a lack of suitable breeding places for its vector, *Culex quinquefasciatus* Say.

These two diseases and the susceptibility of a varied population offer a combination of great concern to the industrial and agricultural future of Surinam. There is also speculation as to the source of these diseases. No doubt the black slave brought potent strains of malignant *Plasmodium* from his native Africa, and perhaps some filariasis as well. The Javanese and British Indians may also have brought in their peculiar strains of malaria. With these combinations of peoples and parasites we wonder that the epidemics of these mosquito-borne diseases were not more serious than have been recorded.

MOSQUITOES OF SURINAM

The mosquito population of Surinam is an extremely varied one. Bonne and Bonne-Wepster (1925) list over 130 species as probably occurring there. Of these, they list *Anopheles aquasalis, A. apicimacula,* D. & K., *A. mediopunctatus* Theo., *A. peryassui* D. & K., and *A. argyritarsis* R.-D. The last species undoubtedly is what we now know as *darlingi* Root.

Aedes aegypti (L.), the yellow-fever mosquito, and *Culex quinquefasciatus,* the transmitter of filariasis, are common everywhere in the villages. Bed nets and insecticide sprays are frequently in evidence. Recently one of us (Geijskes [4]) reported the presence in Surinam of *Anopheles pessoai* Galvao & Lane and *A. shannoni* Davis, two hitherto unknown species in the colony, whereas no specimens of *A. darlingi* were captured. In fact, the collections of anophelines in and around Moengo were greatly different than those reported twenty years previously by Dr. Bonne and his wife.

During these twenty years a considerable change has taken place in the ecological relations of Moengo and its environs. From a small settlement in the deeply shaded jungle, Moengo, now a village of about 1500, has become a veritable island of civilization. Epidemics of greater or lesser severity flourished during the '20's. At that time *Anopheles darlingi* (*argyritarsis* of Bonne and Bonne-Wepster), a particularly effective transmitter of malaria, must have been common. Close by, small settlements of Bush Negroes furnished a ready reservoir of *Plasmodium*. Gradually the jungle was pushed back by engineers who came to mine the rich deposits of bauxite. The Javanese aided in reclaiming the jungle and have cultivated small patches of ground for growing rice, cassava, bananas, tayer, and other crops. There is some reason to believe that that vicious carrier of malaria, *A. darlingi,* may have been driven beyond flying distance of Moengo by a conversion of its preferred shady breeding places into sunny areas conducive to the breeding of other anophe-

[4] Geijskes, D. C. 1946. Notes on the Neotropical Anophelinae in Moengo, Surinam. MOSQUITO NEWS, 6(3):113–118.

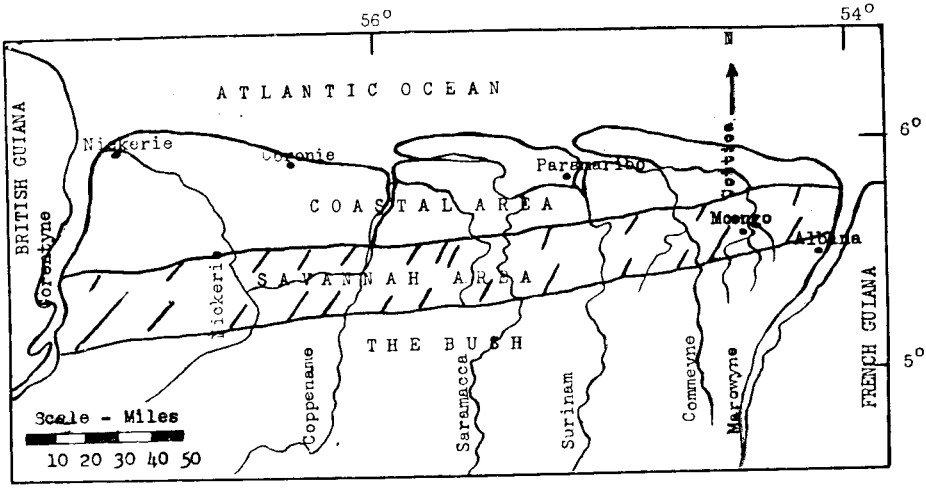

FIG. 1. The coastal area of Surinam is swampy and has a clay soil. South of the coastal area is the savannah, a more or less sandy belt and somewhat higher ground. Still farther south is the bush country. These areas are densely covered with a wide variety of plants and trees. The number of species is enormous. Indeed, the plant population of any acre is so varied that of the individual plants there may be not more than 5% of any one species.

FIG. 2. A typical rice paddy in which each rice plant is transplanted by hand. A grove of banana plants in the background.

lines which do not harbor the parasites of malaria. These ecological changes may or may not have been responsible for radical changes in the pH of the water, but on this point we have no information.

Few Indians live in this general area and so present no problem, but there are villages of Bush Negroes on every side. The Moengo authorities have taken steps to prevent these people from remaining within the village after dark. This practice undoubtedly is a great aid in keeping malaria to a minimum. The situation calls for the utmost vigilance in Moengo, however, because all the conditions necessary for a severe epidemic of malaria are ever present in the neighborhood.

Malaria transmission in the jungle of Surinam is due largely to the presence of *Anopheles darlingi*. This mosquito breeds mainly in shaded swamps overgrown with aquatic vegetation along the upper rivers in the interior. We think this explains the badly infected Bush-Negro villages, which are always situated on the banks of the rivers, whereas the Indians living in the drier savannahs suffer much less with malaria.

Severe outbreaks of pest mosquitoes often occur in northwestern Surinam in the districts of Coronie and Nickerie. There *Anopheles aquasalis* is very common, but curiously enough malaria is not present. In fact these districts are the healthiest in the colony. There are reports that severe malaria epidemics have occurred in northwestern Nickerie. These epidemics may have been caused by a temporary influx of *A. darlingi* from the upper river, or by the transportation of *Plasmodium* from the interior by bush laborers coming home in large numbers within a short period of time and infecting the *A. aquasalis* breeding there.

Although Surinam and British Guiana are similar in climate, topography, and agriculture, there is not a comparable occurrence of malaria in the two countries. Malaria is much more disastrous in British Guinana than it is in Surinam, because *A. darlingi* enters the coastal area of British Guiana in contrast to its absense in Surinam.

"INFLUENCE OF NATURAL WATERS ON THE EFFECTIVENESS OF DDT AS A MOSQUITO LARVICIDE"

(Copied from Bulletin of the Army Medical Department, Vol. IV, No. 6 (Dec., 1945), pp. 633–634.)

"Suggestions have come from the field to The Surgeon General's Office that the chemical constituents in natural waters might influence the effectiveness of DDT as a mosquito larvicide. To test this possibility, studies were carried out by the Fourth Service Command Laboratory at Fort McPherson, Ga. The kill of early fourth instar *Anopheles quadrimaculatus* larvae and of third instar *Aedes aegypti* larvae in various test waters was compared to that in a standard water. For *A. quadrimaculatus* larvae the standard water was distilled water raised to a pH of 8.0 with sodium carbonate; for *A. aegypti* larvae it was distilled water with a pH of 6.8. The standard amounts of DDT used were 0.0015 and 0.03 parts per million for *A. aegypti* and *A. quadrimaculatus*, respectively. These amounts of DDT killed from 70 to 100 per cent of larvae in forty-eight hours in the standard water.

"The test waters consisted of thirty-six samples of natural waters obtained from various locations in the Fourth and Eighth Service Commands and also synthetic waters made by adding to distilled water varying amounts of single chemicals commonly found in natural waters. An attempt was made to test natural waters with widely different chemical compositions. The findings in the laboratory were confirmed by tests made in the field.

"The conclusion reached from the studies was that no material in solution in natural waters interfered with the forty-eight hour kill of mosquito larvae by DDT provided that the proper amount of DDT for the particular species of mosquito was applied."