

MALARIA AND MOSQUITO SURVEY AT CARIPITO AND QUIRIQUIRE  
VENEZUELA, SOUTH AMERICA

June 8-16, 1935

W.H.W. Komp, Sanitary Engineer  
United States Public Health Service

ONE visit was made to Caripito and vicinity, where observations were made in the river swamp lying along the railroad leading to the tanker dock, and of the extensive drainage system installed around the company camp, but most of the investigations centered around Quiriquire, where automobile transportation was provided, and where conditions are not very different from those at Caripito.

Around Quiriquire, visits were made to Rancho Cachipo, some distance beyond the Quiriquire airport on the savannah; to temporary camps near Q 78 location; to permanent Labor camp No. 9; to a temporary camp near the wild-cat well "Caripito No. 1", on the road from Quiriquire to Caripito; to the native village at Quiriquire; to several permanent swamps near these locations; and to a number of "quebradas", deep, steep-sided, heavily wooded ravines around Quiriquire.

#### Mosquito Surveys

At the suggestion of Dr. A.M. Walcott, of the Rockefeller Foundation, who visited Quiriquire recently, Dr. Urquhart had made two mosquito traps, which could be baited with a live animal. These proved of great assistance in catching both Anopheles and other types of mosquitoes and as they were portable, could be moved from place to place during my stay. Collections were made of the mosquitoes caught in them daily each morning.

Fifteen species of Anopheles mosquitoes are known to occur in Venezuela. Two of these are reported on the basis of old observations (probably erroneous), leaving 13 species as certainly occurring. Another species, Anopheles kompi Edwards, was found on this visit, adding one more species to the list. Altogether, six species of mosquitoes were taken during my visit. These are listed in the following list:

*Eke Medical Bulletin* 2(5): 204-16, Nov. 1935

<u>Anopheles</u>	<u>darlingi</u>	Root
"	<u>oswaldoi</u>	( <u>basinaculatus</u> Peryassu
"	<u>apicimacula</u>	D. & E.
"	<u>mediomunetatus</u>	Rhee
"	<u>strodei</u>	Root
"	<u>kompi</u>	Edwards

Of these six species, Anopheles darlingi is by far the most dangerous. A. oswaldoi is not considered an important carrier, although it belongs to the same group as does A. darlingi, and has been found infected. The other four species have never been found infected in nature, and are thought not to be of any importance in malaria transmission. The presence of A. darlingi in eastern Venezuela, where it has never before been reported as occurring, probably accounts for the high malaria rates found in the vicinity of Quiriquire and Caripito. This is due to two factors: A. darlingi is easily infected with malaria, it enters houses freely, and it is avid for human blood. Davis (1931) found 22.3 percent of this species infected at Belem and Para in Brazil. Davis and Kumm (1932) and Kumm (1932) found this species to be a vector in other regions in the State of Bahia, and Bennaroch (1931) found 12 out of 114 that were dissected to be positive, in the region around Maracay, Venezuela. Compared with A. oswaldoi, it is a much more potent carrier. In 400 dissections by various workers in South America, an infection rate of only 0.8 per cent was found in A. oswaldoi.

#### Anopheline species - Adults

Anopheles darlingi was found on numerous occasions resting on the walls of the rooms of temporary camps (near location Q 78, and near "Caripito Well No. 1"). As many as seven were taken from one room and all gorged with blood. Approximately 25 were taken from one camp, at one visit. At no time were any taken in the animal traps. This shows the preference of this species for human blood; and together with the ease with which it can be infected, explains why it is a mosquito against which the greatest control efforts must be directed.

Anopheles darlingi was taken in animal traps regularly, both at Parque Cachipo near Quiriquire, and at "Caripito Well No. 1." One specimen was taken in the first animal

along the railroad leading to the loading dock at Caripito while in the act of biting me. The presence of large numbers of cattle at Rancho Cachipo probably explains why it was found in greatest numbers there. Probably it prefers animal blood.

Anopheles apicimacula was taken while biting freely in the river swamp at Caripito, where it was flying with A. oswaldoi, though greatly outnumbered by the latter species. It is usually a shy biter, but not so in this locality, where it attacked without hesitation. Because it belongs to a group none of whose members have been found infected in nature, it is not considered a dangerous mosquito.

Anopheles pseudomaculipes, considered rare in other parts of Venezuela, was taken in fair numbers in animal traps, both at Rancho Cachipo, and at "Caripito Well No. 1." It also belongs to the same group as the preceding species, and is not known to be a carrier.

Anopheles konji was taken once, a single female, in a deeply shaded quebrada near Camp No. 2, near Quiriquire. It is not known to be a malaria carrier.

#### Anopheline species - larvae

The larvae of Anopheles darlingi were taken in three different types of breeding places, corresponding to the findings with regard to this species made by Root in his visit to Northern Venezuela in 1927. These breeding-places were grassy, open, sunlit swamps, open borrow-pits along roads and grassy permanent pools. All these occurrences were in waters near human habitations.

A. darlingi larvae were never found in shaded swamps, in shallow temporary road-pools without vegetation, or in any type of water which was heavily shaded from the sun, although many searches were made for them in the wooded quebradas or ravines.

A. oswaldoi larvae were taken in the same swamp near Caripito Well No. 1 in which A. darlingi were breeding; also in a partly sunlit swamp near Rancho Cachipo. However, it was not found in the quebradas, as it is a more shade-loving species than A. darlingi.

What I believe to be the larvae of A. pseudomaculipes were taken in a small leafy pool in the bottom of a deep quebrada near Quiriquire. These were all first-stage larvae,



in which the characters necessary for complete identification had not yet appeared. As the larvae were undoubtedly those of a species of the group Arribalzagia to which A. pseudomaculipes belongs, I believe that they are of this species.

A single larva of A. kompi was taken in a pool in the same quebrada in which the Arribalzagia larvae were found.

A single larva of A. strodei was taken in an open, grassy swamp near location Q 78, near Camp 9.

The breeding-places of A. anicimacula were not discovered, but no doubt could be found in pools in the jungle of the river swamp.

Shannon (1933) states that in the Amazon Valley Anopheles darlingi is primarily a flood-water breeding species. That it is not confined to such waters is certain from Root's findings, as he took it in parts of northern Venezuela in stagnant ditches, and in small pools, ponds, marshes and permanent pools with sunlight and abundant vegetation. Root's findings agree with those of mine. The difference serves to emphasize the fact that each area is a law unto itself, and observations made in one region may not apply, except in a general way, to another region with different local conditions.

### Non-Anophelines

In view of their importance as pests, and because of their recent implication as carriers of yellow fever, collections of non-Anopheline mosquitoes were made as opportunity permitted. Here the animal traps proved of great assistance. The following list gives the species taken, in what is believed to be their order of importance as biting pests, and as potential carriers of yellow fever. A large number of species collected are not known to feed on man. This is particularly true of certain of the Culex species, which are never found far from their jungle breeding-places, and are usually never taken except as larvae in their various breeding-places.

Culiseta inornata, Pa. Juhard Theo.  
Cu. kneri, Knab  
Cu. albipennis, Fabr.

- Genus Haemagogus. 2 female specimens, which cannot be identified as to species. Males are necessary for the determination, as there are no good color characters within the genus.
- Genus Mansonia. 2 female specimens, not certainly identifiable, but most probably M. nigricans Coq.
- Genus Aedes. A. serratus Theo  
2 species, one probably A. fluviatilis, the other probably a new species of the subgenus Finlaya.
- Genus Joblotia. J. digitata Rondani
- Genus Hyeomyia. Several species biting freely, not recognizable certainly without males.
- Genus Limatus. L. durhanii Theo.
- Genus Lutzia. L. allostigma H. D. & K. The larva is cannibalistic.
- Genus Culex. C. chrysonotum D & K  
C. coronator D & K  
C. corniger Theo.  
C. (Carrollella) urichii Coq.  
A dozen or more other species, of no medical importance, collected by sweeping with a net in the jungle.  
Probably several new species are included.
- Genus Uranotaenia. U. calosomata  
U. orthozya, probably. (These mosquitoes do not bite).
- Genus Megarhinus M. haemorrhoidalis Fabr. The larva is cannibalistic, feeding on other larvae. The adult cannot bite.

Of the non-anopheline species listed, the only ones of any medical importance belong to the genera Psorophora,

Haemagogus, Mansonia and Aedes. Besides being possible carriers of yellow fever, mosquitoes of the genus Psorophora may carry the eggs of Dermatobia hominis, the human warble-fly. The genus Haemagogus is under grave suspicion as a natural carrier of yellow fever in parts of Colombia. Mansonia is also able to carry the disease under experimental conditions, and various species of Aedes have also been implicated.

Psorophora mosquitoes breed in temporary rain pools in the jungle and in semi-permanent swamps. Two species of larvae were taken in a wooded swamp near Rancho Cachipo. The adults were abundant in the woods nearby and were also plentiful in the "monte" near Caripito Well No. 1. A few specimens were taken in the river jungle area near Caripito.

Mosquitoes of the genus Haemagogus usually breed in tree-holes, although in Panama I have found two species breeding in ground-pools among rocks and in cocconut husks containing water. Two adult females of this genus were taken, one in an animal trap near Rancho Cachipo, and the other was caught biting in the "monte" near Camp No. 2.

The larvae of the genus Mansonia are peculiar among mosquitoes, in that they never come to the surface to breathe air, but pierce the stems of aquatic vegetation, grasses, reeds and rushes, with the tip of the breathing tube, and thus obtain oxygen from the plant tissues. Drainage is the only way of controlling this pest, other than covering their very extensive breeding-places with a complete and constant film of oil. Two specimens of females of this genus were taken in animal traps, one at Rancho Cachipo, and the other near Caripito Well No. 1.

The single common species of Aedes found in the "monte" (wooded jungle) was Aedes serratus, which also breeds in the same kind of waters as does Psorophora. Larvae were taken with those of Psorophora in a wooded semi-permanent swamp near Rancho Cachipo. The other genera contain mosquitoes which, for one reason or another, are not of medical importance, and will not be discussed further.

It is interesting to note that no larvae or adults of the common yellow fever mosquito, Aedes (Stegomyia) aegypti, or of the common house-mosquito of the tropics, Culex tritaeniorhynchus, were seen during my stay in eastern Venezuela. As these mosquitoes breed in artificial containers, cans, bottles, jars for drinking-water, etc., it speaks well for the sanitation of the camps that none were found.



Should yellow fever ever appear in eastern Venezuela, which seems unlikely, its control would be a difficult matter, if the vector were one of the forest mosquitoes. Some measure of protection, however, might be obtained by cutting down the jungle for a distance around the wells, camps, etc., to prevent harborage of the jungle-haunting species, which do not like to leave the forest shade.

### Housing Conditions

The condition of the houses in Caripito and Quiriquire for the foreign employees was admirable. One factor which would help to discourage harborage of mosquitoes is to prohibit the planting of masses of shrubs and vines close to the houses, as there is a great tendency in the tropics to wall in the houses with as much ornamental plantings as possible. This is a serious mistake in mosquito-infested countries, as shade and moisture favor mosquitoes of all kinds.

Screening is the first line of defence in tropical countries against mosquito-borne diseases. In general, the screening was good in Caripito and Quiriquire. However, in the house where I stayed, near the Club in Quiriquire, several holes were noted in the screens in the porch. During my stay, one was repaired, but the others had been overlooked. Thorough inspection and careful follow-up by a responsible person are necessary to keep the screens in good condition. Although the houses were provided with double-screened vestibules, it was noted that almost without exception the inner door of the vestibule was tied or propped open. This defeats the purpose of a screened vestibule, and should be made the subject of a general letter of instruction, with penalty for infraction of the rule.

In some of the permanent labor camps, where the new type of hollow-tile houses were in use, sanitary conditions were good, and in none of them were mosquitoes of any kind found. A striking example of this was noted at Camp 9, which is within sight of the temporary camp at Q78. No mosquitoes were found in any of the rooms at Camp 9, which is built of tile, while in the temporary camp as many as seven A. darlingi were taken in one room. Although a large number of rooms in the old and new houses at Camp 2 were examined, no mosquitoes of any kind were found in them. This is perhaps

due to the open, light condition of the rooms, and to the fact that they were well whitewashed. This of itself seems to make conditions in the houses unfavorable for mosquitoes, and the measure should be extended to all the other permanent camps.

It seems that there is a good chance to try out the effect of screening in some of the permanent labor camps. The houses are very well built, and would lend themselves well to screening. It is recommended that a single camp, with a known high malaria rate, be selected, and the houses, both windows and doors, screened. The screens should be made of as heavy wire as possible with large mesh, as this is more durable than fine mesh wire, and would be just as effective against *Anopheles* mosquitoes. Particular attention should be paid to the doors, to make them "kick-proof." Instructions should be given the camp "corporal" or overseer, to the effect that he see the screen doors are not tied or propped open, especially at sundown. After the screening is installed, its purpose should be explained to the camp people, and they should be notified that any breaks in the screens in their quarters would be repaired by the company at the expense of the householder. After a number of seasons, the people would get used to using the screens properly, and they might be successful in lowering the malaria rate.

The problem of the temporary camps is a difficult one, as they are erected in connection with wild-cat wells, or other temporary projects. It is never known how long such projects will last, therefore, it is uneconomical to spend much money on housing for the laborers. No doubt, it is in these camps that the greater number of malaria cases among the natives are contracted. A malaria survey of one such temporary camp, in which an attempt at prophylaxis had been made, showed six persons out of fourteen examined to have malaria parasites in their blood. It was in such a camp that great numbers of *A. darlingi* were found in the rooms, resting on the walls of the temporary shacks. For lack of any better measure, the use of bed-nets should be made compulsory in all such camps. These should be supplied by the company, regularly inspected, at least every two weeks, and kept in repair. A bed-net full of holes becomes a mosquito trap, and is a detriment instead of a protection.

With regard to the night workers, no recommendations for malaria control that are worth while can be given.



the nature of their work renders them especially liable to infection. All that can be done is to give them adequate treatment when they succumb to the disease. In the case of valuable personnel, such as engineers and superintendents, some slight measure of protection might be obtained by the use of atabrine, given prophylactically, a tablet a day, provided exposures were not over too long a period. Experiments with this drug for this purpose seem to hold out some promise of usefulness. Quinine prophylaxis in this connection seems almost useless, for it will not prevent infection and the men will not take it regularly, because of its unpleasant by-effects.

Closely bound up with the question of malaria control in the foreign population is the proximity of the native villages near Quiriquire and Caripito. A certain percentage of the foreigners will insist upon spending some of their evenings and nights there. The location of the Quiriquire villages is such that doubtless many mosquitoes are present during the rainy season, and probably a large number of the natives are infected with malaria. Exposure to infection under such conditions is inevitable. Except for measures of a general sort, such as reducing mosquito breeding around such towns by the use of Paris green or drainage, no worthwhile recommendations can be made. It is questionable whether any disciplinary measures would be of use, in controlling the habits of the men who frequent the native towns. But it seems inevitable that malaria infections will occur, no matter how good conditions are in the foreign settlements, so long as such foci of infection exist in close proximity to them. The presence of a dangerous malaria carrier, *A. darlingi*, and the existence of the native towns, so close to the foreign settlements, seem to be the two main factors in producing and keeping up a high rate among the foreign employees.

### Blood Surveys

Previous to my arrival in Quiriquire, I had asked Dr. Urquhart to take a thick blood film on every patient entering the hospital until the time of my leaving. The forty-two slides so obtained were taken to the Gorges Memorial Laboratory where they were stained and examined. Nine positives, one a duplicate, were found in the 42 slides. It is probable that some were missed, as not all of the

slides were in good condition. The older ones in particular did not take the stain well. The rate obtained, 21.4 per cent, gives a good idea of the hospital malaria seen at this season of the year. A duplicate set of slides was retained at the hospital and their record of findings will be compared with mine. There seems to be some prejudice on the part of the laboratory force against the routine use of the thick film in malaria diagnosis.

In view of the proved value of this method, and its demonstrated superiority for diagnostic purposes over the thin film, every effort should be made to improve the technique, and to make it routine on every case entering the hospital. The chief criticism I would make of the present method is that insufficient blood is placed on the slide, not more than half enough to make a good thick smear. By so doing, the value of the thick film method is lost. The time of staining was also too short, and should be increased to one hour. Instruction was given in these matters, which, it is hoped, will improve the technique. Instruction was also given in the survey methods used by Barber and the author, by which large numbers of slides can be stained and examined with a minimum of handling. A survey was made at one of the temporary camps, to demonstrate the method. As mentioned before, this survey showed a total of six positives out of 14 bloods taken.

### Prophylaxis

An attempt is being made to reduce the amount of malaria in the temporary camps by the use of prophylactic drugs, such as quinine, atabrine, and plasmochin. The camp mentioned above as having had six positive out of 14 persons examined had been under this regime for some time. The results show the ineffectiveness of such a procedure, if the administration of the drugs is not supervised by some responsible person, and accurate records kept. Even then, it is extremely doubtful whether prophylactic measures will serve to keep down the malaria rate in years when the rate is naturally increasing.

Certain recent work done by the author and Dr. H.C. Clark in Panama throws doubt on the practicability of drug treatment in reducing the malaria rate in a native population, or of controlling epidemics of malaria by the treatment of the affected population. Conditions in eastern Yucatán are too



sufficiently different to warrant continued trial of the method, but only if it is supplemented by monthly blood examinations, and if the treatment is properly supervised.

### Causes of High Malaria Rates

Statistics, to be of any value, should be obtained from comparable material. Unless the malaria statistics of the various South American divisions of the Standard Oil Company are derived from similar material, they are invalid as indicating differences in the malaria rate. They may also show an untrue picture of the success or failure of malaria control operations in the various divisions. It is perfectly possible for one division to have as much or more malaria than another, and yet publish a lower rate, if the diagnosis of the disease is faulty. I do not know what precautions, if any, are taken to guard against such errors. It is suggested that an investigation may show, in divisions reporting a low malaria rate, that the laboratory diagnosis of the disease may be poor; that "fevers of undetermined origin" may be in excess in such divisions; and that so-called "clinical" malaria, not confirmed microscopically by the thick film, may play a part in apparently keeping up a high rate.

It is also a matter of experience in Panama and other tropical areas, that the malaria rate is subject to wide fluctuations, of unknown cause. Therefore, it may be unfair to compare the rates in a division in which severe malaria has recently occurred, with a division in which the malaria rate has been lowered from natural and unexplained causes. "Bad" years tend to alternate with "good" years, and only in the long-term view can it be determined if improvement in conditions is taking place. On the basis of the statistics of malaria in the Standard Oil Company of Venezuela's division, it appears that the rate there is not unduly high. They are, considering all the conditions, excellent for the foreign population. While it is not suggested that no improvement is possible, yet it appears that rapid improvement will not be possible. The division, because of its peculiar local conditions, will always have a certain irreducible minimum of malaria, beyond which expenditures would be out of all proportion to the benefits received.



## Conclusions

The presence of Anopheles darlingi in eastern Venezuela is undoubtedly the reason for the high malaria rate found there. This mosquito possesses all the requirements for being a dangerous carrier, as it is easily infected, apparently prefers human blood, and enters houses freely. As it breeds in different sorts of open waters, with vegetation, the problem of its control is a difficult one. Particular attention should be paid to artificially created breeding places in the vicinity of temporary camps, such as borrow-pits along the roads and pools left by other excavations. The fact that it does not breed in the "quebradas" seems to indicate that extensive drainage of such places is unnecessary. Temporary breeding in pools in such locations could easily be controlled by oiling. All other species of Anopheles found in my survey are unimportant in the transmission of malaria, so that all efforts should be directed against the breeding-places of A. darlingi.

No worthwhile recommendations as to the control of the jungle-infesting species of non-anopheline mosquitoes can be made, because of their widespread and inaccessible breeding places.

With reference to housing conditions, it is recommended that ornamental plantings be placed at a considerable distance from the company houses, in order to reduce the possibility of mosquito harborage. Adequate inspection and repair of screening at short intervals is also recommended. Whitewashing of the interiors of the permanent labor camps seems to reduce mosquito harborage therein, and the measure should be continued and extended.

It is further recommended that an experimental screening project be undertaken in some permanent labor camp, the inhabitants to be held responsible for the maintenance of the screens. Bed-nets, inspected and kept in good repair, should be furnished the inhabitants of all temporary camps in the absence of other more effective measures.

The problem presented by the proximity of the native villages to the company camps is discussed, but in view of the costly malaria control measures required in their vicinity, it is doubtful whether a great deal can be done to reduce their menace.

It is recommended that the thick film method of diagnosing malaria be improved and extended. Monthly surveys following supervised prophylactic treatments, would give definite information concerning the effectiveness of this measure.

The suggestion is made that the relatively high rate found in the Caripito Division may be due to differences in reporting the disease among the various divisions of the Standard Oil Company.

### Summary

A list is given of the Anopheles mosquitoes found during the survey, with notes for their control. The finding of a most dangerous Anopheles, *A. darlingi*, may explain the high malaria rate found in the Caripito area.

A similar list of the non-anopheline mosquitoes found, with notes on their occurrence, and their possible relation to the transmission of yellow fever, is also given.

With reference to malaria, housing conditions in foreign settlements, permanent camps, and temporary camps are discussed, together with the problem presented by the proximity of the native villages.

A report on two malaria surveys made in the division is given.

The failure of prophylactic treatment to reduce the malaria rate is discussed, and recommendations made for increasing its effectiveness.

The suggestion is made that what are apparently real differences in malaria rate between different divisions may actually be due to differences in reporting the disease, and to local temporary epidemic conditions.