

Pan American Health Organization

ADVISORY COMMITTEE ON MEDICAL RESEARCH

Seventh Meeting

Washington, D.C., 24-28 June 1968

Special Session on:

Biomedical Challenges Presented by
the American Indian

Item 6.3

MALARIA IN THE AMERICAN INDIAN

Ref: RES 7/SS/6.3
13 May 1968

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MALARIA IN THE AMERICAN INDIAN

Malaria prevails, or has prevailed up to recently, over very wide areas of the Western Hemisphere, lying between latitudes 50°N and 40°S, and from the shores of the Atlantic to those of the Pacific Ocean; the American Indian ranges from Canada to Patagonia, and some thirteen species of American Anopheles mosquitoes have been linked with malaria transmission, seven species being vectors of major public health importance in one country or the other. The range of ecological and epidemiological variation is therefore practically illimited, and it would be quite impossible to submit a concise, comprehensive account of malaria in the American Indian, even if adequate information on the subject were available. Unfortunately, published data are conspicuously absent from the literature, and none of the principal Malaria Eradication Services have been able to supply information on this special malariological problem.

During the great upsurge of antimalarial activities over the last twenty years, emphasis was placed on vector destruction and chemotherapy, and not on epidemiology. Excessive hopes were founded on the new insecticides with long-lasting residual effect, and on the powerful antimalarial drugs developed during the war and in the early post-war period. Malaria eradication campaigns were launched widely and waged with little or no attempt to establish base-line data on the local epidemiology of the disease.

For obvious economical, political and logistical reasons, in the sparsely inhabited countries of the American tropics, efforts were concentrated on the more populous areas, no distinction being made in respect to the

different ethnic groups which might be present. Given the magnitude of the task, the remote, scattered and economically unimportant Indian communities were, to a great extent, missed, overlooked or ignored.

The present discussion will be restricted to the Indians of Guyana, who are estimated to number 32,000, widely scattered over the least accessible parts of the country. At the present day, nine tribes are represented:

The Warau of the coastal lowlands, mostly in the North-West district, adjoining the delta of the Orinoco; the Arawak, of the lowland forests of the near interior; the Wapishana (Arawak stock), of the South Rupununi Savannah; the Carib, formerly very numerous and widely distributed, but now reduced to very small numbers, mainly on the upper Barama and Barima rivers in the North-West District; the Akawai of the upper Berbice, Demerara, Cuyuni and Mazaruni rivers; the Patamona of the southern portion of the Pakaraima Plateau; the Arekuna of the upper Cuyuni and Mazaruni mountains and savannahs; the Makusi of the North Rupununi Savannah and the Wai-Wai of the Essequibo headwaters. The last five tribes are of Carib stock.

Some of these tribes extend beyond the political frontiers into Venezuela and Brazil. Generalisations in re malarica are not permissible, and our observations refer specifically to Guyana; it may be noted, however, that few environments present greater stability and uniformity than the equatorial rain forest, which covers most of the Guianas and Amazonia, where Anopheles darlingi, the most efficient malaria carrier in the Western Hemisphere, is the prevailing, and often the only, vector. It is in this vast region that the majority of American Indians live still fully exposed to the ravages of uncontrolled and untreated malaria.

The study of racial differences in respect to the epidemiology of malaria and the clinical and immunological reactions which are induced by the malaria parasites, presents many difficulties; for valid conclusions studies must be based on observations made under identical conditions of environment and exposure. Such situations are rare, and this is probably the reason why studies on this aspect of malariology are few, and the conclusions drawn somewhat tentative and guarded.

The Negro of West and Central Africa has evolved, throughout the ages, in continued confrontation with malaria, and has acquired practically total immunity to Plasmodium vivax and a high degree of tolerance to P. falciparum. Tolerance to the latter species, implies no immunity to the parasite, but a high degree of tolerance in respect to the effects of parasitization. Raichenow,⁽¹⁰⁾ in 1929, working among the Hausa of the Cameroons, reached the conclusion that toxine resistance was inherited, but parasite resistance was acquired by continued exposure and reached its peak in early adulthood; thereafter, the parasite rate and the degree of parasitization remained low and more or less stable. Others in Africa have reached similar conclusions.

Holoendemic malaria is regarded as the highest expression of malaria endemicity: the spleen rate in children 2 to 12 years old is constantly above 75 per cent.; the spleen rate and the size of the average enlarged spleen fell progressively with age, becoming low or negligible in the adult population. Mortality may be high in young children, but the adults enjoy good health as far as malaria is concerned. Holoendemic malaria is typical of Africa, but has also been recorded in other rather restricted situations as, for instance, among the Aborigines of North-Eastern India and in New Guinea. In the Western Hemisphere, however intense malaria transmission

may be, it has been recorded, to the writer's knowledge, only among the Bush Negroes of Surinam; these are descendants of runaway slaves who have lived, for many generations, isolated in the Guyana forest, where other races, equally exposed, suffer severely and never acquire that high degree of adult tolerance to malaria infection which is characteristic of holoendemic malaria. This suggests that race may be a factor connected with holoendemicity.

Among the Bush Negroes, Swellengrebel and Van der Kuyp (12) found a very high P.falciparum rate both in children and adults; the mortality at all ages was, however, low, and they were not much inconvenienced by the infection. Thus, in a village on the upper Surinam river, P.falciparum accounted for 75 per cent. of infections in children, and for 73 per cent. of infections in adults. The actual parasite rate averaged 70.5 per cent. in children and 37 per cent. in adults, yet during the twelve-year period from 1927 to 1939, the population of the village increased by 30 per cent., from 698 to 901, the average annual death rate being 21, the birth rate 39 per 1000 inhabitants, and the infant mortality 113 per 1000 births! Creole negroes from the Surinam coastland, living in similar surroundings, showed the same or even higher infection rates, and suffered severely.

The Amerindians of Surinam, living under the same conditions as the Bush Negroes, showed little evidence of tolerance to the infection. On the Wayombo river, in September 1939, 172 Indians were examined; P.falciparum accounted for 50 per cent. of infections in children (108 examined) and 61 per cent. in adults (64 examined), and the spleen rates were 82 and 83 per cent. respectively. Swellengrebel and Van der Kuyp found that:

"The adult spleen rate and the average size of the enlarged adult spleen (2.2 Schuffner units) surpassing anything we encountered in Bush Negroes, are evidence of the lack of tolerance of these people to malaria parasites. We may add that a high spleen rate and a large size of the swollen spleen are peculiar of Indian malaria, as distinct from the Bush Negro and Creole malaria one meets everywhere in Surinam... Besides a strong splenic reaction to the presence of malaria parasites in their blood, the Indians give evidence of their lack of tolerance by sickness and deathThe importance of Indians as carriers of malarial infection does not, like the Bush Negroes, consist in a tolerance to the parasite (manifesting itself by a moderate splenic reaction and a low morbidity and mortality), but in their seminomadic life which enables them to carry malignant malaria infection from the Bush to the Savannah. "

American Negroes, descendants from slaves brought from Africa between the XVIth and XIXth centuries, who have lived for generations under conditions of more or less moderate malaria endemicity, still enjoy some of the immunity built up by their ancestors. The North-American Negro presents considerable resistance to provoked infection with P.vivax ⁽¹⁾ and throughout the Caribbean, West Indian Negroes, though equally susceptible to infection, as an average, suffer much less and present lower spleen rates and smaller average enlarged spleens than other races living in the same environment. ⁽²⁾

In Guyana, people of six races⁺ have been living for many generations

+ According to the last census, the population of Guyana in 1960, totalled 560,406, comprising: East Indians 267,840; Negroes 183,980; Mixed 67,189; Amerindians 25,450; Chinese 4,074; Europeans 3,218 and Others 8,655.

in the same general environment and often under the same conditions of exposure to malaria infection. The Europeans, mainly of Portuguese descent, and the Chinese, constitute small minorities and live mostly in Georgetown. The rural population of the coastlands, comprises large numbers of Negroes and East Indians and ideal conditions exist for comparative racial studies of all kinds. Up to 1946, when large scale D.D.T. spraying operations were introduced, malaria used to be stable and hyperendemic throughout the coast, from the Berbice Estuary to the Pomeroon River. ⁽⁷⁾ Systematic surveys of school children were conducted between 1937 and 1946, separate records being kept for the two main races. The parasite rate showed no significant racial variation; splenic reaction in the Negroes was, however, decidedly and consistently more moderate, and decreased rapidly with age so that spleens of considerable size were rarely found in the older children and even less frequently in adults.

In East Indians, on the contrary, the incidence and degree of splenic enlargement was much higher and hardly affected by age. Clinical experience in Sugar Estate hospitals showed that the majority of adults went through life afflicted by large, and often very large spleen, and failed to come to terms with the infection; they suffered frequent attacks of fever, and anaemia of some degree was practically universal. Mortality, directly due to malaria, was highest in children, but the tolerance established in adults, by life-long exposure to infection, was both low and unstable; at all ages, malaria, and its sequelae continued to be major causes of death.

The 239,000 immigrants who came to Guyana from India between 1838 and 1917, originated mainly from Bengal, Bihar, Orissa, the Central Provinces and Madras, where malaria mostly, though not exclusively, is hypoendemic or

mesoendemic, and seasonal in its occurrence. This explains the lack of any inherited resistance to malaria and the severe reaction these immigrants suffered when they were transferred to the hyperendemic Guyana coastland.

Further inland, along the tidal course of the Berbice, Demerara and other rivers, the autochthonous population is formed by Amerindians of the Arawak and Akawai tribes^{and} by persons of mixed race, usually with Amerindian, European and Negro blood, in very variable proportion. There are few permanently settled negroes, but a considerable fluctuating population of this race, mainly adult males, is employed in the mining and timber industries. At the time when malaria was hyperendemic in these districts, the Negroes came, not only from the intensely malarial coast, but also, and in high proportion, from the more mildly malarial Leeward and Windward Islands and from malaria-free Barbados. Whatever their origin, their reaction to malaria infection followed the same pattern; soon after arrival they contracted the infection, suffered an attack or two of fever and after that they enjoyed normal health and rarely returned for treatment.

In contrast, the mixed population, born and bred in the area, suffered severely and continuously, all ages being affected; mortality and morbidity were certainly graver in children, but the tolerance acquired by the adults was poor and very unstable. The Amerindians reacted in the same way as the mixed population, but even more severely; the largest spleens recorded, reaching the pubis, and partly filling the pelvis, were seen in adults of this race.

Blackwater fever was not common in Guyana, in spite of the very high incidence of P. falciparum; it appeared at long intervals, during periods

of malaria exacerbation, tending to recur in some localities, with clustering of cases in certain neighbourhoods, homes and families. On the Demerara River, between 1923 and 1931, fifty-three cases were recorded, mainly in 1926-1927, with the following racial incidence (4):

<u>Race</u>	<u>Incidence of Blackwater Fever</u>	
	<u>Per 1000 Inhabitants</u>	<u>Per 1000 Patients treated</u>
Negroes	2.67	19
East Indians	24.00	191
Amerindians	11.79	84
Mixed Races	21.83	189

Nephrosis and chronic nephritis, associated with P.malariae infection, were frequent on the Demerara River; racial incidence per 1000 patients during eight years, was: 20.4 in Negroes; 48.8 in East Indians; 33.6 in Amerindians and 35.6 in Mestizos. Children and young persons are more liable to blackwater and nephrosis than adults, thus the low incidence of these syndromes in Negroes might be due, to some extent, to the preponderance of adult males in this ethnical group. Ten years' experience on the Demerara River, in conclusion, showed that the Arawak and Akawai Indians of the area, suffered severely from malaria and its complications and, like the East Indians of the Coastlands, acquired only a very relative degree of tolerance to the infection, suffering from its effects at all ages.

In the far interior, the population is widely scattered and can be estimated at 45,000 (1967), of whom approximately half are Amerindians belonging to the Wapishana, Macusi, Patamona, Akawai, Arakuna and Carib tribes. On the Rupununi Savannas and the Pakaraima Plateau, the inhabitants are nearly exclusively Indians. Among them, malaria surveys have been few

and irregular and no systematic, long-term observations have been made; the same can be said of other medical studies. Prior to the introduction of control measures, malaria occurred throughout the year but transmission tended to be much more seasonal than on the coast, being related either to the May-August rains, or to the floods of the larger rivers. Among the Indians of the low-land forest, spleen rates ranged from 40 to 60 per cent.

In some of the less accessible areas, the introduction of malaria appeared to be recent, and possibly related to increased traffic with the coastlands; thus, the Savannahs of the Rupununi, which were difficult to reach before the advent of the aeroplane, were reported to be healthy up to 1930; the only Indians who suffered being those who had visited the coast, travelling down the Essequibo river or driving cattle through the Berbice trail. By 1938,⁽⁵⁾ the infection had spread all over the savannahs, and over 30 per cent. of the children had enlarged spleens, rates increasing with age. By 1943,⁽⁶⁾ fears were entertained that the Makusi of the North-Savannah were dying out. During a malaricastic survey of this area, 424 Indians of all ages were examined; 68 per cent. had either enlarged spleens, parasites, or both, and 46 per cent. of adults had large spleens which in 20 per cent. of cases extended below the transverse umbilical line. In settlements situated nearest to the forest, 80 per cent. of the inhabitants showed evidence of malaria. The lack of old people was very striking; only two were seen who appeared to be about 60 years old. This was reported to be a recent development and that before malaria appeared on the savannah, in 1930, old and very old people were numerous. One rancher who came to the area in 1922 had known two Macushi ancients who remembered quite well the British military expedition to Pirara in 1843! During this 1943 survey, many settlements in

the Indian Reservation along the northern Kanuku Mountain foothills, were found deserted, and some of the houses burned, as is customary after the death of an inmate.

This high susceptibility of the Guyana Indians to malaria, is without doubt one of the major causes of their decline over the past 150 years. Smallpox, measles, yellow fever, influenza, whooping cough and tuberculosis, have all been contributing factors, sometimes causing disastrous epidemics; none of these diseases, however, was as constant in its onslaught as malaria.

The early Dutch colonists sought the alliance of the Indians, particularly of the Caribs, then a very numerous and warlike tribe, as they relied on them for the procurement of Indian slaves, captured in raids on villages and Spanish Mission settlements on the upper Cuyuni and Orinoco. Later, during the long years when African slaves were brought to the Colony, both the Dutch and the British planters relied on Indian help for subduing slave rebellions and for the capture of fugitives. From 1778 to the end of slavery, annual official receptions were held in honour of the Indian Chiefs. At the end of the eighteenth century, the Amerindian population appears to have been numerous and flourishing; the figures that have been given, however, are unreliable and differ widely; 50,000 would appear to be a reasonable guess. With the abolition of slavery, the Indians ceased to be of any interest to the Colonists, and were left to themselves and neglected; their numbers dwindled rapidly, and the Caribs, the most powerful and feared tribe, practically vanished; only a few survive at the present day on the upper Barama and Barima rivers. In 1848, after proper surveys, it was established that the Guyana Amerindians aggregated approximately 15,000, of whom only 7,000 still in the aboriginal or semi-aboriginal state.⁽³⁾

Systematic malaria-control operations were inaugurated in the interior in 1947; though eradication has not as yet been achieved, the incidence of the disease has been drastically reduced. The rapid increase, which has followed, in all the tribes, is a clear indication of the disastrous effect of malaria on this population group over the past years; in 1968, their number is estimated at 32,000.

This high susceptibility and reactivity of the Amerindian to malaria, is without doubt related to the recent introduction of the infection in the Western Hemisphere. It is generally accepted that malaria, as well as many other diseases, came to America with the discoverers, the conquistadores, and the hundreds of thousands of slaves brought from West Africa. In the Americas, the new arrivals found, wherever they landed, native Anopheles capable of acquiring and transmitting the disease; given the prolonged infectivity of malaria subjects, the lack of curative medicines at the time, and the wide diffusion of Anopheles, it is not surprising that serious, early outbreaks occurred among the invaders, and that the infection spread rapidly to the highly receptive Indians.

In spite of tradition, it appears that even the Peruvian Indians were ignorant of the properties of Chincona bark. Richard Spruce,⁽¹¹⁾ the botanist, spent fifteen years, from 1849 to 1864, on the Amazon, and in the Chincona forests on the slopes of Chinborazo in the Equadorian Andes. He was responsible for the collection and shipment of seeds and young plants from which the Chincona plantations of India and Ceylon eventually originated. He found that the "Cascarilleros", Indians employed in the collection of Chincona bark, were not only completely ignorant of its medicinal properties, but regarded his explanations with scepticism and suspicion, for they were convinced

that the bark was used for the extraction of a valuable brown dye.

In equatorial America, altitude, in the Andean Cordilera, has probably been the only barrier to the spread of malaria, even to the most remote and isolated Indian communities. The Wai-Wai Indians are an entirely primitive tribe, which has its main settlements in Brazil on the Mapueira river, which flows, through the Trombetas, to the Amazon, some 400 miles to the South. A few used to visit the headwaters of the Essequibo in Guyana. Their nearest neighbours ~~to the north~~, are the Wapishana of the South Rupununi Savannah, some 70 miles to the North-West, through high rain forest. Cassava graters and feather ornaments have been traditional items of trade between these two tribes, but contacts ~~have been rare and~~ are maintained by only a few individuals. For the last 15 years, a mission has been established at Kanashen, on the upper Essequibo, and it has attracted considerable numbers of Wai-Wai from across the border. In 1966, a group of 80 paid their first visit to the mission, after a journey of several weeks; of these, 14 were found infected with malaria, P.falciparum, P.vivax and P.malariae, all being identified.

So far we have dealt with the incidence of malaria and its effects on the American Indian; the Indian's way of life, however, also has important bearings on malarial epidemiology and even more so on the practical development of antimalarial operations.

Indian villages are small in size, with widely spaced houses; the larger buildings usually accommodate several families, each having its fireplace and allotted space. Completely isolated houses are frequent. The large villages, to be found in the more civilised areas, are due to missionary

influence. The houses are made out of materials which are easily procurable on site; round wood poles, bush ropes, palm leaves for roof thatching, bark and split palm trunks for walls and floors, etc. By community effort even the larger houses can be erected in the course of a few days, and a serviceable shelter may be put up in a matter of hours. This makes it easy for the Indians to move from one site to another, either for security, for better hunting or fishing and, probably, for the purpose of escaping disease. As has been mentioned, houses in which a death has taken place are frequently abandoned and burned down. This instability of settlements has been recorded by most observers, and it is reasonable to expect that such a practice may help in the avoidance of malaria which, in the forest, is eminently a place disease, prevailing in localities where conditions for abundant A. darlingi production exist.

The more permanent type of house, constitutes the Indian's operational base, but, with his entire family, he spends a large proportion of his existence elsewhere, working on his farm, usually situated at a very considerable distance, on hunting or fishing expeditions, attending sprees, or just visiting his neighbours. In the more civilised areas, he may seek temporary employment as a guide, a porter,^a boat-hand, bleeding balata, collecting Brazil nuts, etc., and when so engaged he is usually accompanied by his family. When away from their permanent home, the Indians camp under temporary shelters, ranging from a few large palm-leaves stuck into the ground, to an open palm-thatched shed.

This great and continuous mobility of the Indian, is without doubt a factor favouring the wide and rapid diffusion of malaria infection. In 1947, a sharp outbreak of malaria occurred among the Patamona Indians on the Potaro-

Ireng watershed, on the Pakaraima Plateau, a mountainous, mainly forested region, at an elevation of 1000 to 2000 feet above sea level.⁽¹⁾ Infected persons were discovered scattered widely over some 500 square miles; all of them, however, had worked at, or had visited recently, a diamond placer, and this was the only locality where transmission was actually occurring; a creek had been dammed, and many gravel pits sunk in the valley bottom, and in these A.darlingi found ideal conditions for continued production. The migration of 80 Wai-Wai, of whom 14 were malaria parasite carriers, has already been mentioned.

These characteristics of the Indian way of life introduce serious difficulties in practical malaria control, and may frustrate even the most efficient eradication programme. In the sparsely inhabited interior, A.darlingi, in adaptation to the environment, is in no way as anthropophylic and endophylic as it is on the coast; it is widely distributed as a silvatic mosquito, and malaria transmission takes place not in villages and houses, but at camping sites, on the farms and in the forest. The main villages can be sprayed with insecticides without excessive difficulty, but the existence of remote, isolated houses is very frequently unknown, and the systematic spraying of temporary shelters is not only impossible, but futile, as they offer next to nothing in the way of sprayable surfaces. Under such conditions, insecticidal methods can reduce, but not eradicate, malaria, and their application is difficult and expensive. Systematic spraying of hammocks with D.D.T. solution or emulsion is a useful practice, as the Indian always travels with his hammock, and the insecticide residue resists occasional washing.

Mass chemotherapy, through systematic, periodic distribution of anti-malarial drugs, is obviously impracticable, owing to the terrain, the widely

scattered population and its elusiveness. Even when a case of malaria has actually been discovered, treating it is a difficult matter; radical treatment of P.falciparum infection needs at least three days, and for P.vivax, 14 days are required. Pinning down an Indian for regular daily dosage is no easy matter, and he usually fades into the forest in mid-treatment!

In Guyana, malaria, and its carrier A.darlingi, were eradicated from the coastlands and the more accessible and populated inland areas (93 per cent. of the population) exclusively by D.D.T. house spraying.⁽⁷⁾ In the far Interior, results were by no means satisfactory, and malaria control only, was established. This partial failure of D.D.T. was due to the wide scattering of the population over an impervious terrain, its instability and mobility and, above all, to the silvatic adaptation of A.darlingi.⁽⁸⁾

From January 1961 to December 1965, an attempt was made to eradicate these residual foci of malaria in the interior, by means of chloroquinised-salt;⁽⁹⁾ in order to assess fully the value of this new technique, D.D.T. house spraying was suspended. This campaign covered an area of 42,000 square miles (109,000 Km²) and a population of 48,500, mainly Amerindians. The campaign was conducted under strict administrative and scientific control; specific legislation was enacted, making the use of chloroquinised-salt compulsory in proclaimed areas, and regulating its shipping, transportation and sale in the interior. Epidemiological evaluation preceded, accompanied and followed the campaign. In the areas in which chloroquinised-salt was used, continued D.D.T. operations, from 1947 to 1960, had greatly reduced the frequency of the disease; the reservoir of infection within the population was therefore a relatively small one.

In the North-West District and in the Pakaraima sectors, aggregating an area of 35,000 square miles (91,000 Km²) and a population of 39,550 (1964),

malaria (parasite rate in 1960 = 8.3 per cent.), disappeared within six months; thereafter, only four sporadic, cryptic cases of P.vivax infection were recorded up to April 1965, when the campaign was closed down.

Early in 1966, ten months after the cessation of all anti-malarial measures in the area, a small focus of P.vivax infection was discovered among the Caribs of the upper Barama river, a very inaccessible locality where chloroquinised-salt could only reach irregularly and probably in insufficient quantity, as no shops or other normal means of salt distribution exist. These Indians, travelling down the Barama, spread the infection to the Waini and Moruca rivers, and, crossing overland, caused an outbreak at the Manganese Mines (M.M. on map) on the upper Barima and Kaituma rivers. Hence the infection spread rapidly to the lower course of these streams and to the Aruka.

In June and July, the outbreak reached its peak, with 372 widely scattered cases. During 1966, a total of 643 cases were recorded on a total of 20,811 slides examined, out of a population of 16,850; P.vivax was the only parasite involved. The outbreak has been controlled by D.D.T. house spraying and re-issue of chloroquinised-salt, these techniques being used in combination for the first time. Only 15 cases were recorded in 1967 (9,116 slides examined) and none during the last four months, from December 1967 to March 1968.

An identical incident occurred among the Akawai Indians of the Wenamu and upper Cuyuni, along the Venezuelan border, the first cases being discovered in April 1966, one year after the cessation of anti-malarial operations. This, again, is a very inaccessible area with a small population of Akawai Indians who can obtain salt and other supplies more easily from Venezuela

than from the Guyana side; P.vivax was responsible for all cases discovered. Indians crossing overland from the Wenamu to the Kamerang, an affluent of the Mazaruni, spread the infection to the upper Mazaruni and its tributaries, a sparsely inhabited area with an estimated population of 3,000 Indians and diamond miners. During 1966, 280 cases were discovered in this sector. Many infected persons reached the coastlands, but were intercepted by systematic examination of plane passengers from the Interior. D.D.T. house spraying and chloroquinised-salt, (issued free to Indians) have brought the situation under control, though progress has been slow, owing to the very difficult terrain.

It is important to note that both these recrudescences were due exclusively to P.vivax; the 1961-65 medicated salt campaign, even in remote and poorly supplied areas, appears to have achieved the eradication of both P.falciparum and P.malariae which, before the introduction of chloroquinised salt, accounted for 57 and 15 per cent. of infections, respectively.

Among the 10,000 Makusi and Wapishana Indians who inhabit the Savannas of the Rupununi, close to the Brazilian border, chloroquinised-salt, after a favourable start during 1961, failed owing to the introduction of a chloroquine-tollerant P.falciparum strain from the neighbouring Rio Branco Territory. This new strain spread rapidly over the whole area, even where chloroquinised-salt coverage was adequate; D.D.T. house spraying, interrupted since 1960, was re-introduced in 1962, and as soon as systematic spraying operations were established by the Brazilians across the border, beginning in January 1965, malaria transmission on the Savannas was interrupted. Silvatic A.darlingi, however, still persists in the surrounding forest and occasional cases of P.falciparum malaria continue to occur, but exclusively among Indians

engaged in bleeding balata⁺ who camp in the forest during the rainy season, from April to November. Among 700 bleeders and their dependants, estimated at 2,800, 24 cases were discovered in 1966, and 22 in 1967.

For the 1968 season it is proposed to issue to all bleeders, along with the other rations they receive, 20 lbs. of salt, medicated with chloroquine (0.43 per cent. chloroquine base), and pyrimethamine (0.043 per cent.) and, in addition, to give to every individual, who can be "caught" before leaving for the forest, a two-day combined Fanasil (Sulfurthomidine) - Pyrimethamine treatment. The result of this new approach will not be known till the end of the year.

These various developments, which have occurred in the course of the Guyana campaign, illustrate clearly the peculiar difficulties encountered in the course of malaria control and eradication operations among the Amerindians. In the early planning of the many campaigns which have been undertaken of late years throughout tropical America, as has been stated, little importance was attached to the specific problem of malaria in the Amerindian, priority being given to the larger, more accessible communities, which were economically more important and politically more vocal. Today, with eradication or, more frequently, control established over wide areas, the problem of malaria among the Indians, assumes a new dimension, for it is evident that eradication will remain a dream until ways and means have been discovered to extend control to even the most remote of Indian settlements. We have shown how rapidly and widely malaria can be broadcast from extremely limited foci, by wandering/^{OR}migrating Indians.

+ Wild rubber.

Of the preventive techniques known at the present day, medicated salt appears to be the most promising, as it can find its own way far beyond the reach of organised public health agencies. We do not yet possess, however, the ideal drug for this purpose. Those in use today, among other shortcomings, fail to act on certain parasite strains, and may thus bring about the emergence, and favour the diffusion of ~~such~~ drug-tolerant or drug-resistant infections, ~~thus failing to achieve eradication and~~ introducing therapeutic problems which may be serious.

In Guyana, we have shown ~~however~~ how chloroquinised-salt was completely successful against all forms of native malaria parasite, only failing where and when a chloroquine-tolerant strain was introduced from Brazil. Our campaign, it should be emphasised, was inaugurated at a stage when the reservoir of infection had been greatly depleted by D.D.T. spraying. Under such conditions, the probabilities of resistant strains being present were much reduced. With the drugs at present available, we believe that medicated-salt should not be used under conditions of high endemicity.

Indians, still in the aboriginal stage of civilisation, do not know commercial salt and manufacture salt substitutes by washing certain soils, or the ash of certain palms. Natural deposits of salt are not likely to occur throughout the vast equatorial rain forest. On the other hand, the civilised and semi-civilised Indians, take to the use of commercial salt very readily, as in it they find not only a means for seasoning their food, but a valuable preservative for fish and game on which they subsist, and which tend to abound in certain seasons and not in others; the traditional method of preservation employed, is smoking. The entirely primitive Wai-Wai Indians, for instance, who reach Kanashen Mission from the depth of the Brazilian

Virgin Forest, take to the use of salt with great readiness, as soon as it is made available.

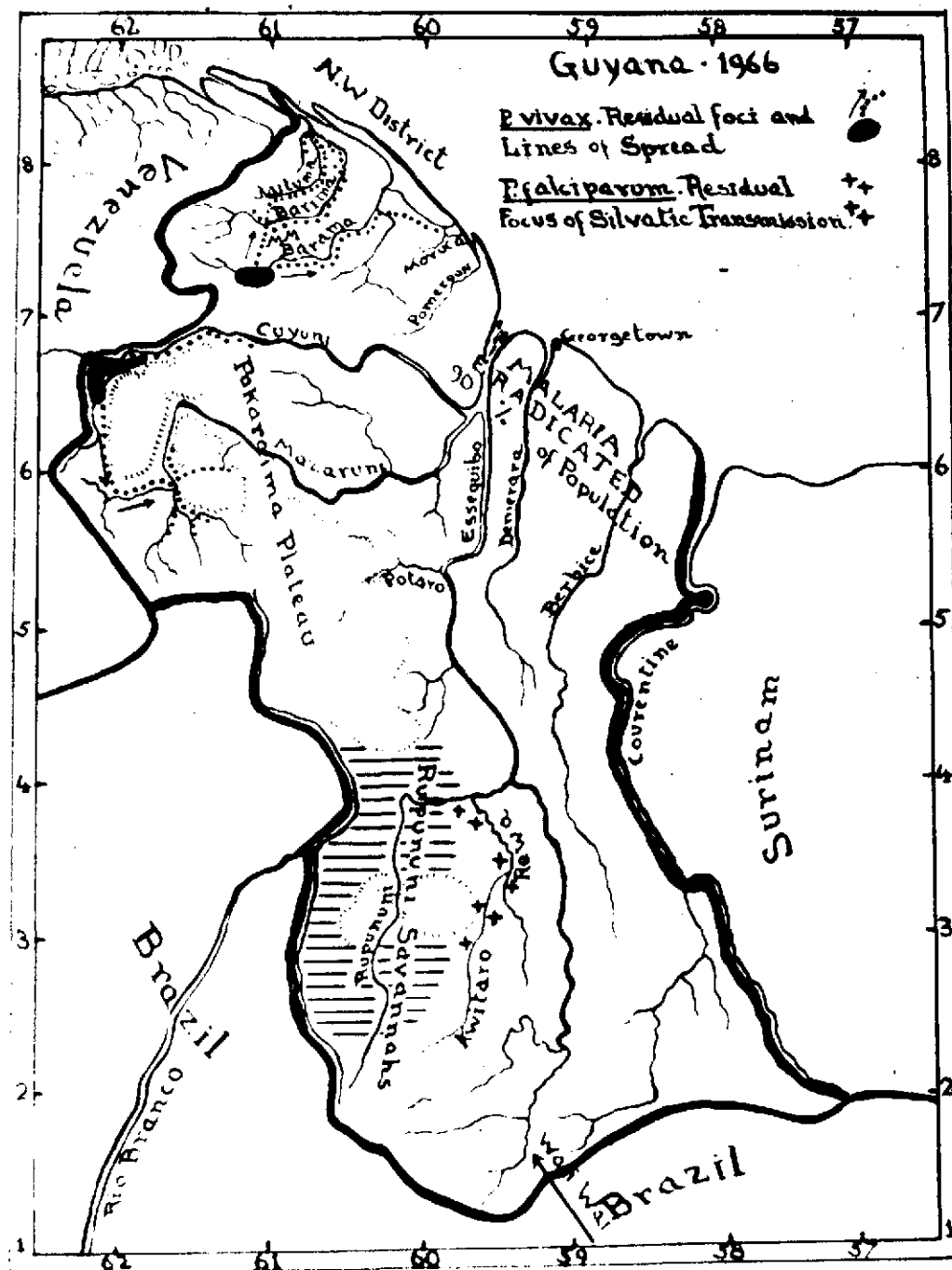
Obviously, spreading the use of salt to the more remote tribes, will and the same can be said for take years/ malaria eradication, where primitive Indians exist; ~~is without~~ ~~doubt a very long-term project~~; at the present stage of malariological knowledge and anti-malarial technique, it appears likely that treatment and prevention may be extended more easily to the primitive and semi-primitive Indians, through the established channels of inter-tribal barter trade, in a bag of salt than through a spray gun or a bottle of tablets; for this purpose, however, more effective drugs for salt medication have to be found.

May, 1968

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Map of Guyana showing residual Plasmodium vivax foci which survived the 1961-65 chloroquinised-salt campaign in remote, inaccessible areas, and the lines of spread of the infection by wandering Amerindians. In the Northern half of the country chloroquinised-salt eradicated both P. falciparum and P. malariae.

In the South, the campaign failed, following the introduction of a chloroquine-tollerant P. falciparum strain from Brazil in 1962. D.D.T. house spraying on both sides of the border has interrupted transmission on the permanently inhabited Rupununi Savannahs, but a small focus of P. falciparum, transmitted by silvatic A. darlingi, persists among Amerindian balata-bleeders who camp, with their families, in the otherwise uninhabited Rewa-Kwitara forest, from May to November. In all, 3,500 persons are involved, with an annual average of only 24 cases.

In the extreme South, the point of intrusion of primitive Wai-Wai Indians, is indicated.