Highly Prevalent Falciparum Malaria in North West Guyana: Its Development History and Control Problems[1]

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After being absent from North West Guyana for over two decades, falciparum malaria returned in force in 1986 and soon developed a high prevalence affecting a large share of the region's inhabitants. This falciparum upsurge was accompanied by a significant rise in the number of vivax cases that helped bring the annual parasite index to figures ranging from 260 positive smears per 1 000 inhabitants in 1986 to 973 in 1988 and 776 in 1991.

The chloroquine-resistant P. falciparum *strain responsible apparently travelled from the area of the Rupununi River in Southern Guyana to the more northern Cuyuni/Mazaruni/ Potaro area in 1985, and from there was brought into the North West Region, probably by itinerant miners. Circumstances leading to the present endemic demonstrate how transient populations, resistant parasites, and economic restraints can interfere with malaria control, and how rapidly high malaria prevalences can establish themselves in receptive tropical areas vulnerable to attack.*

Guyana's North West Region (Region I), encompassing an area of 26 000 km² and occupying the northern tip of the country, extends from an eastern boundary, situated roughly 70 km west of the Essequibo River, to Venezuela and the Orinoco Delta (Figure 1). Before Independence in 1966, the area was inhabited largely by members of three indigenous Amerindian tribes, these being the Arawaks, Caribs, and Warau. Basically, these were and still are people living in small communities who make their living from slash and burn agriculture (shifting cultivation), hunting, and fishing, and who also sometimes work as guides and loggers.

After Independence, there was a considerable influx of other people, mainly Negroes and East Indians, to this region. The population rose from an estimated 5 000–7 000 Amerindians around 1945 to an estimated 16 000–18 000 inhabitants in 1992. Much of the increase came as a result of mining activities undertaken mainly in the Arakaka, Matthew's Ridge, and Port Kaituma areas. Among other things, a government program of structural adjustment designed to increase and sustain economic development boosted the gold and diamond industry from 1988 onward by providing a variety of incentives and concessions including tax holidays. The number of legally registered Region I miners as of 1992 was 3 785, a total supplemented by some 1 568 unregistered miners (personal communication, Malaria Supervisor, Region I). These latter unregistered miners consisted almost exclusively of individuals or small groups engaged in marginal operations.

This article briefly reviews the situation in Region I from 1945 to 1992 in order to

[1]The statements and opinions contained in this article represent the views of the author and are not to be construed as official views or as reflecting the views of Guyana's Ministry of Health or any agency of the Government of Guyana.

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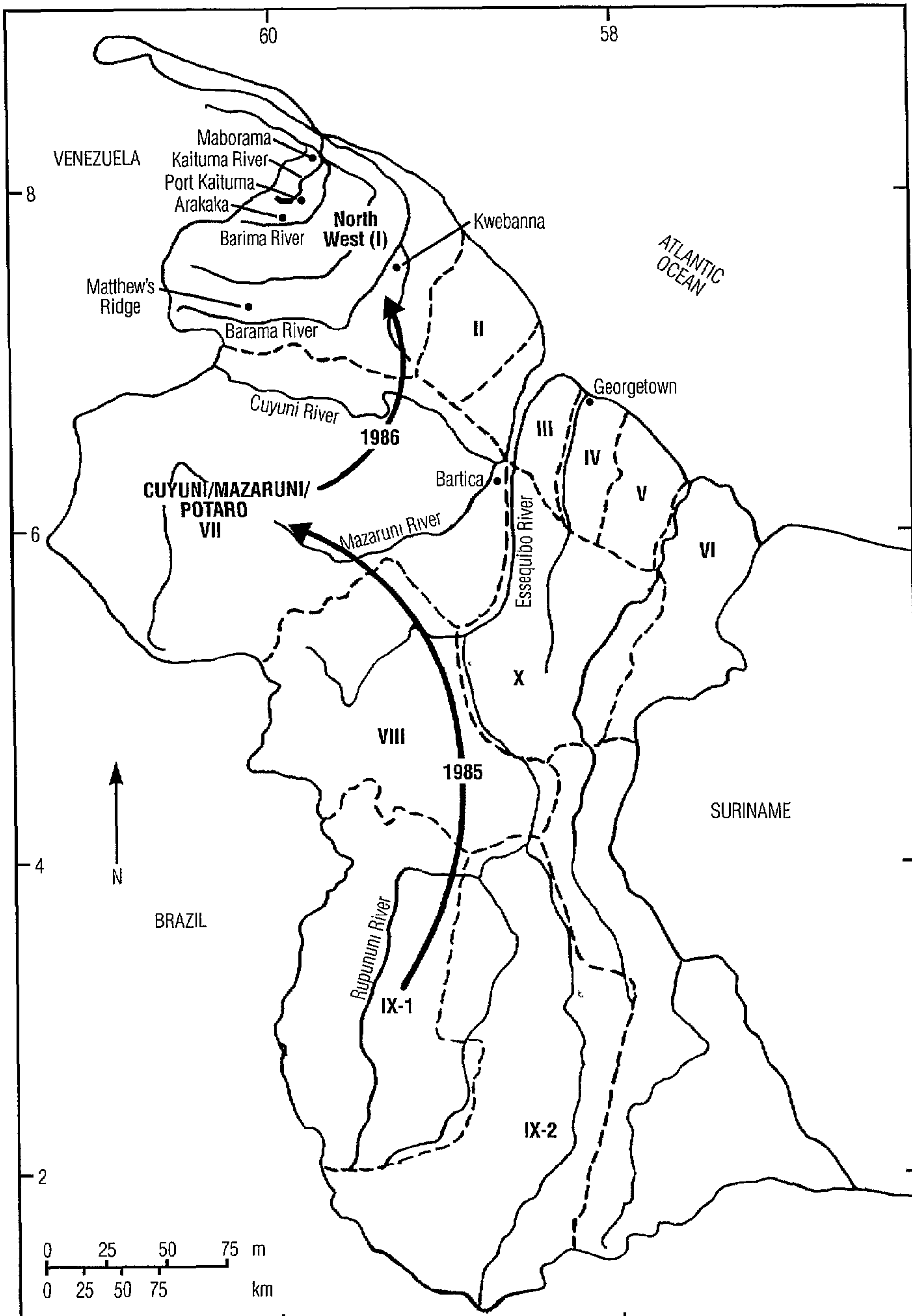

Figure 1. A map of Guyana showing the North West Region (Region I) and the areas from which falciparum malaria was imported in 1985 and 1986.

clearly document the reappearance of falciparum malaria after an absence of 24 years, followed by a progressive upsurge in the numbers of falciparum and vivax cases.

HISTORY

Antimalaria measures succeeded in eradicating the vector *Anopheles darlingi* from Guyana's coastal areas and interrupting transmission there by 1951 (*1*). However, only incomplete control was achieved in the interior. DDT spraying operations on the lower reaches of the main rivers, which had been halted around 1951, were resumed in September 1958, shortly before a significant malaria outbreak occurred in North West manganese mining areas on the upper Kaituma and Barima Rivers.

Starting in January 1961, following reported eradication of malaria from bordering areas of Venezuela, an effort was made to eradicate residual malaria foci by distributing salt containing chloroquine; DDT spraying and other antimalarial drug distribution were discontinued before this campaign began (*2*). The campaign succeeded to a point where transmission was interrupted and malaria parasites disappeared within 6 months.

Parasitologic surveys conducted in 1960 found 402 of 4 840 smears positive (211 for *Plasmodium falciparum*, 120 for *P. vivax*, 52 for *P. malariae*, and 19 for both *P. falciparum* and *P. vivax*). In contrast, 22 160 smears examined from July 1961 through December 1965 revealed only four sporadic unconnected cases of vivax malaria, all in the Moruca River District, a small area with about 4 000 inhabitants (*3*). Subsequent examination of 5 791 smears in the Moruca District in 1965 revealed no further cases.

However, in 1966, about a year after distribution of chloroquine-containing salt was discontinued, a major resurgence of vivax malaria prompted renewal of both DDT spraying and issuance of chloroquine-containing salt. These measures brought the problem back under control temporarily, only 17 malaria cases being recorded in 1967 and only 3 from 1968 through 1975; but thereafter the numbers of cases rose again, and from 1976 onward endemic vivax malaria persisted throughout the North West Region, 5 219 cases being detected in the 1975–1985 period.

In contrast, no cases of falciparum malaria were recorded in the 1961–1985 period. In 1986, however, substantial numbers of falciparum cases were reported as part of a major malaria upsurge that year. Since then, falciparum malaria has become firmly established, maintaining a very high level of endemicity (*4, 5*).

MATERIALS AND METHODS

The data presented in Tables 1 and 2 were compiled from entomologic and parasitologic investigations conducted by the author (*6–8*), using information gathered by members of the Malaria Control Program, a number of voluntary collaborators, and various health centers and "cottage" hospitals. Both active and passive case detection methods were employed by control program workers throughout the region, while passive case detection methods were used by the local health facilities and volunteers.

The active case detection work involved searching for malaria cases within the population through house-to-house visits and then obtaining blood smears to screen people with fever or a history of recent fever. Passive detection, in contrast, depended on people with fever reporting to a fixed malaria detection center or health post, where a blood smear was taken and where in many cases presumptive suppressive treatment was provided. Supervisory centers in the North

Table 1. Data on malaria cases found in the North West Region, 1945–1992, showing the 1945–1984 data by 5-year periods and the 1985–1992 data by year. Smear data for 1945–1984 are not classified by collection method (active or passive). *P.f.* = falciparum case, *P.v.* = vivax case, *P.f.v.* = combined falciparum and vivax case, *P.m.* = malariae case, API = annual parasite index (no. of positive smears per 1 000 inhabitants), and SPR = smear positivity rate (% of all smears yielding positive results).

		No. of smears		No. of malaria cases					
Period	Population	Active	Passive	*P.f.*	*P.v.*	*P.f.v.*	*P.m.*	API	SPR
1945–49	5 000	55		0	0	0	0	0	0
1950–54	8 500	275		1*	25	0	0	3.1	9.5
1955–59	9 700	1 050		26	31	3	5	6.7	6.2
1960–64	12 800	22 767		227	159	20	56	36.1	2.0
1965–69	15 500	61 808		0	664	0	0	42.8	1.1
1970–74	16 300	75 215		0	0	0	0	0	0
1975–79	18 000	120 515		1*	1 568	0	0	87.2	1.3
1980–84	15 700†	97 166		0	2 630	0	0	167.5	2.7
1985	15 000	2 150	11 515	0	1 021	0	0	68.1	7.5
1986	15 500	3 201	15 361	2 268	1 763	2	0	260.2	21.7
1987	16 000	6 284	35 268	6 818	5 446	34	0	768.6	29.6
1988	16 500	10 722	48 425	10 977	4 992	80	0	972.7	27.1
1989	16 900	14 499	34 071	4 762	3 210	57	0	475.1	16.5
1990	17 000	12 405	31 005	5 597	4 340	52	0	587.6	23.0
1991	17 600	6 000	43 090	7 462	6 136	63	0	776.2	27.8
1992	18 000	12 100	42 594	7 874	5 870	36	0	765.6	25.2

*Cryptic case.
†Decline due to migration.

West, each staffed by a malaria microscopist, were located at Mabaruma, Arakaka, Matthews Ridge, Port Kaituma, and Kwebanna (Figure 1).

RESULTS

Table 1 indicates the numbers of cases detected in the North West Region from 1945 through 1992, by 5-year periods through 1984 and thereafter annually, showing the numbers of smears examined, the malaria species detected, the number of positive smears per 1 000 inhabitants (annual parasite index, API), and the percentage of all smears yielding positive results (slide positivity rate, SPR). A total of 253 cases of *P. falciparum* were recorded as occurring in 1959–1961, of which 211 were detected in 1960. As may be seen, *P. vivax* endemicity in this period remained low, and the API and SPR were both relatively low compared to the situation prevailing after 1985.

After a 24-year hiatus, aside from a single cryptic[3] case, the first falciparum case was recorded in March 1986. From then on the rate of falciparum cases increased rapidly, predominating over an accompanying upsurge of vivax cases and contributing a majority of the positive cases accounting for very high positive smear rates (both API and SPR) prevailing through the end of the observation period in 1992. (Overall, the API from 1986 through 1992 ranged from 260 to 973, the average for the period being 659, while the SPR ranged from 17% to 30%, the average for the period being 24.4.) Also, the average active case detection, as a percentage of active plus passive case detection, was only 25% between 1985 and 1992.

[3]An isolated case not associated with secondary cases.

Table 2. Epidemiologic data on recorded North West malaria cases, 1986–1992, by type of case (falciparum or vivax), showing the percentages accounted for by adults versus five childhood age groups, males versus females, and members of the mining community.

	P. falciparum cases in:							*P. vivax* cases in:						
	1986	1987*	1988*	1989	1990	1991	1992	1986*	1987*	1988*	1989	1990*	1991	1992*
Total no. of cases	*2 268*	*6 818*	*10 977*	*4 762*	*5 597*	*7 462*	*7 874*	*1 763*	*5 446*	*4 992*	*3 210*	*4 340*	*6 136*	*5 870*
% of cases by age group:														
0–11 months	0	0	0.2	1.5	2.4	1.7	2.2	2.9	3.1	2.9	2.7	3.0	3.1	3.7
12–23 months	0	0	0:6	2.3	2.8	3.6	3.3	3.1	3.8	3.0	3.3	4.2	3.7	4.2
2–4 years	0	0.7	1.5	6.1	7.4	8.5	9.3	7.2	8.0	7.6	7.8	9.6	10.8	10.8
5–9 years	2.1	3.3	5.0	10.7	12.1	11.9	12.1	12.8	13.1	13.0	13.8	14.1	14.7	13.5
10–14 years	4.5	6.6	8.0	10.6	12.2	12.0	14.0	13.1	12.7	12.9	13.4	12.4	14.6	14.1
≥15 years	93.4	85.1	70.3	68.8	63.1	62.3	59.1	53,7	55.5	56.1	59.0	55.9	53.1	54.3
% of cases by sex:														
Males, cases	85.7	79.8	68.1	64.2	53.8	61.2	56.8	56.5	54.2	56.1	58.0	55.6	58.5	54.4
(Males, gametocyte carriers)	(28)	(18)	(16)	(15)	(15)	(17)	(18)							
Females, cases	14.3	20.2	31.9	35.8	46.2	38.8	43.2	43.5	45.7	43.9	42.0	44.4	41.5	45.6
(Females, gametocyte carriers)	(31)	(15)	(13)	(14)	(14)	(15)	(17)							
% of cases in mining community members	*97.2*	*85.5*	*78.3*	*72.0*	*70.1*	*68.1*	*65.0*							

*Age group data approximate (total ≠ 100%).

In sum, while it should be noted that some individuals had multiple cases, the number of falciparum and vivax cases detected in 1992 alone was large enough to exceed two-thirds of the Region's total population of 18 000 inhabitants.

As Table 2 shows, males accounted for most of the recorded malaria cases in 1986–1992. However, in the case of vivax malaria the male predominance was relatively slight and stable, while in the case of falciparum malaria the male predominance was very marked at the start of the period (accounting for 85.7% of the cases), diminishing slowly to the relatively slight male predominance seen in vivax malaria cases at the end. Especially at the beginning, as in the case of male predominance, adults (those ≥15 years of age) accounted for most of the falciparum infections.

These changing falciparum trends are consistent with the fact that in 1986, when the outbreak began, nearly all the recorded falciparum cases (97%) were concentrated within the mining community. Thereafter there was a slow but steady decline in this percentage, so that as of 1992 the mining community accounted for a somewhat smaller share (65%) of all recorded falciparum cases.

Regarding seasonal trends, peak numbers of 1986–1992 vivax and falciparum cases were detected in July; however, active transmission continued throughout the year, averages by month ranging from 228 to 1 220 falciparum cases and 380 to 930 vivax cases (Figure 2).

DISCUSSION AND CONCLUSIONS

This malaria situation in the North West constitutes part of a major setback for the Guyana Malaria Program. It now appears that exclusion of falciparum malaria from the North West could be accounted for by the negligible number of miners who ventured into the North West from the Rupununi River area of Southern Guyana, the only area where indigenous falciparum malaria existed in Guyana prior to its reintroduction into the area of the Cuyuni, Mazaruni, and Potaro Rivers in 1985 (4). However, once *P. falciparum* was reintroduced into the Cuyuni/Mazaruni/Potaro area, it was quickly spread by

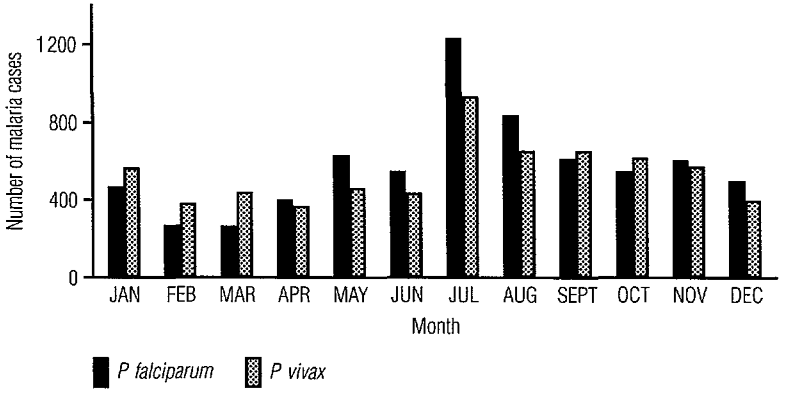

Figure 2. Average monthly distributions of recorded falciparum and vivax malaria cases in Guyana's North West Region, 1986–1992.

miners to other regions including the North West.

This *P. falciparum* from the Cuyuni/Mazaruni/Potaro area was chloroquine-resistant. Its arrival in the North West thus altered the situation described by Giglioli in 1967 (*3*) as follows: "The disappearance of *P. falciparum* and *P. malariae* from the whole North West district and Pakaraima sectors and the resurgence of *P. vivax* in restricted areas where the supply of chloroquinised salt was irregular and inadequate appears to indicate that the latter parasite required greater and more consistent chloroquine dosage than either of the other two species."

Mining appears to have played an important part in the parasite's travels. Before 1985, gold and diamond mining was only undertaken by a few itinerant workers ("pork-knockers"). Around that time, however, a significant increase in mining activities occurred, large-scale mechanized operations were introduced, and a number of foreign mining (and logging) concerns with sizable capital investments became involved.

Epidemiologic investigations seem to indicate that the present outbreak originated from *P. falciparum* gametocyte carriers who came from the Cuyuni/Mazaruni/Potaro area, where a sharp upsurge in both falciparum and vivax malaria that began in 1985 (*4*) has continued to the present. The initial reservoir of infection seemed concentrated within a very mobile mining population, but this subsequently spread out to involve virtually the entire local North West population. This conclusion is supported by various 1986 findings, including the fact that nearly all the recorded falciparum cases (93.4%) were detected in people ≥15 years old, that males accounted for 85.7% of the falciparum cases, and that 97.2% of the falciparum cases were detected in people associated with the mining community (miners, other mining camp personnel, food vendors, prostitutes, and others from nearby villages seeking odd jobs or having some close association with the camps).

Also, continued involvement of the mining community was reflected in the fact that throughout 1986–1992 male adults (males ≥15 years of age) accounted for most of the falciparum and vivax cases. The problem may have been aggravated by a tendency of mining community members to seek medical attention only after self-medication did not provide the desired cure. This delay tended to foster substantial numbers of gametocyte carriers among individuals whose infections persisted for some time after inadequate or inappropriate treatment. It also appears noteworthy that peak transmission typically occurred in July (see Figure 2), as the early dry season was easing, mining activities were peaking, and the vector *Anopheles darlingi* population was at its height (*7*).

As previously noted by the author and others (*5, 8*), indigenous malaria and *An. darlingi* tend to be found together, to such an extent that if this mosquito is rare or absent, so is the disease. In most instances it is the only anopheline found in the inland areas of the North West, and during the rainy seasons it can be observed at high densities along riverine areas where dense forest canopies provide protective cover for its movements (*9*).

In isolated settlements, *An. darlingi* is known to disappear almost completely for part of the year due to periodically unfavorable breeding conditions (*10*). At the same time, in another locality, breeding conditions may be more favorable. By travelling extensively, infected miners tend to provide a year-round presence in places where *An. darlingi* densities are sufficient to continue transmission.

Although *An. darlingi* is known to be fully susceptible to DDT (*6, 7*), DDT spraying of mining camp shelters has

tended to have little effect. This can probably be explained by the excito-repellent effects of DDT on *An. darlingi*—as previously observed in Guyana (*6, 9*), Suriname (*11*), and Brazil (*12, 13*). This is especially likely because *An. darlingi* can easily escape from the sprayed camp shelters, which are generally makeshift and lack walls, without picking up a lethal dose of DDT. In addition, because the mining camps are dispersed over large areas and often change location, spraying campaigns directed at them tend to be costly and hard to organize.

All of these difficulties have been compounded by the problem of broken treatment. Miners tend to be very mobile, moving from one site, camp, or Region to another as discoveries are reported elsewhere. This has made it difficult to administer even 4-day or 14-day radical treatments (for falciparum and vivax malaria, respectively) and has contributed to a rate of broken treatment in the mining areas exceeding 35%.

Use of insecticide-treated mosquito nets might prove useful, but several practical problems need to be overcome. To begin with, many miners who sleep in hammocks do not already possess a net, so a system would have to be set up, possibly in collaboration with the Miners' Association, to advocate the use of nets and to make insecticide-treated nets available cheaply. Further, steps possibly involving health education would need to be taken to prevent overly frequent washing of the nets by their users. (In neighboring Suriname, impregnated nets were not considered a practical malaria control method for the local Maroon[4] population because of the residents' established habit of washing their nets weekly—*14*.) The usefulness of this measure could also be hampered by the fact that many miners continue to work at night. In short, while treated bed nets could conceivably prove useful, detailed studies of this and other measures will be needed in order to determine the most appropriate control methods.[5]

The extent of the challenge posed by rampant malaria has been sharpened by Guyana's grave economic picture, fast-paced inflation, and rapid devaluation of the Guyana dollar (US$ 1 = G$ 129), all of which has imposed further limitations on already tightly restricted antimalaria operations. Among the major limitations are: (a) budgetary reductions in the foreign exchange needed to purchase drugs, reagents, equipment, and supplies; (b) inadequate or unavailable transportation, sometimes due to poor maintenance or commandeering of vehicles; (c) pay too low to retain capable staff; (d) weak technical and administrative leadership; and (e) lack of commitment.

All of this has contributed to maintenance of a "crisis management" policy for dealing with malaria and continuation of a predominantly passive case detection system in which active case detection accounted for only 21% of the total smears examined from 1986 through 1992, despite an increase in the slide positivity rate from 8% in 1985 to 22% in 1986 and growth of the annual parasite index from 68 in 1985 and 260 in 1986 to 769 in 1987.

Overall, the recent experience of the malaria-receptive and vulnerable North West has provided a vivid demonstration of the following points: (1) the extreme difficulty of maintaining eradication of any malaria species indefinitely in a continental tropical forest setting; (2) the capacity of economic constraints to greatly

[4]The Maroons are a tribe of bush negroes living in the forested interior of Suriname, Guyana's neighbor to the East.

[5]See also Richards FO, Flores RZ, Sexton JD, et al. Effects of permethrin-impregnated bed nets on malaria vectors of northern Guatemala. *Bull Pan Am Health Organ*, Vol. 28, No. 2, 1994.

reduce antimalaria activities; (3) *An. darlingi's* key role as a malaria transmitter in our region; (4) the difficult control problems that can be posed by itinerant workers, in this case miners (and also loggers) moving within malarious zones and from highly malarious to nonmalarious areas; and (5) the need, even in hard-to-reach areas, for continuous epidemiologic surveillance and viable health education programs directed at malaria control. By now this latter need has become very clear in the North West and indeed throughout the endemic malarious portions of Guyana, where the current collection of imposing problems threatens to permit spread of the disease to other areas and has dimmed future prospects for control.

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