SYMPTOMLESS PLASMODIUM VIVAX PARASITAEMIAS AND MALARIA ERADICATION IN SANTA CATARINA STATE, BRAZIL

S. Avery Jones * and Joaquim Alves Ferreira Neto **

Thirty-nine symptomless carriers of P. vivax *parasites in the blood gave blood films at monthly intervals for four to six months during the non-transmission season. It was found that parasitaemias can continue for many months.*

Thirteen of those studied relapsed with symptoms and were treated with chloroquine at a dosage of 600 mg for adults with proportionate doses for children. Of these nine relapsed silently while under observation: a symptomless relapse rate of approximately 70 per cent.

One case had symptoms attributable to malaria close to the time of the original survey (the day before). Of the remaining 38 asymptomatic parasite carriers four showed microgametocytes in a density that suggested a potentially high infectivity and six showed microgametocytes in a density suggesting a potentially low to moderate infectivity for mosquito vectors.

There was thus a proportion of one smptomatic case of malaria to 10 potentially infective symptomless parasite carriers.

Because they feel no need to seek treatment, such persons may form an important reservoir of infection when vectors cannot be fully controlled by spraying. Some possible methods of dealing with such situations are discussed.

The ccastal belt of Santa Catarina State in Brazil was extremely malarious with spleen rates of 30 per cent. to 55 per cent, in many places until a combination of residual spraying with DDT and the use of all village schools as treatment centres were employed to combat the disease.

The only vectors found are *Anopheles (Kerteszia) bellator* and *A. (K) cruzii* which breed in water trapped by bromelia plants, both arborial and terrestrial, that abound in the prevailing forest areas. Deforestation and manual removal of bromelias proved effective in reducing transmission but was economically possible only around the larger towns.

The main transmission season extends from December to May, according to Bustamante & Ferreira (1949) and Rachou (1952). For the rest of the year the State is frequently swept by cold south winds. In July and August night temperatures can fall to 7-10°C (45-50°F), and though on sunny days during the winter the vectors can still bite in the shelter of the forests, it is very unlikely that parasites could mature in the mosquitos at the prevailing temperatures. Unusually warm

* Formerly of WHO/PAHO Malaria Eradication Project Brazil-24.
** Of the Campanha de Contrôle e Eradicação da Malária, Federal Government of the United States of Brazil.

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TABLE 1

MONTHLY RESULTS OF SLIDES EXAMINED AT TOWN POSTS IN SANTA CATARINA STATE

		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1961	Number positive	402	358	403	328	214	149	189	220	283	298	391	317
	Number examined	1164	1112	1171	1102	855	645	765	772	768	976	1184	1077
1962	Number positive	557	449	426	462	289	150	205	269	258	374	340	485
	Number examined	1783	1685	1372	1425	1028	633	678	958	713	1030	997	1238

conditions in June or in October/November might extend the transmission season in some places during these months. The vectors bite freely in forest shade at any time of the day in warm weather and will also enter house to feed at night.

Partial spraying began in 1948 and was extended in 1949 and subsequently a network of treatment posts supplying antimalarial drugs was set up in village schools using the school-teachers as voluntary collaborators. For the past five years chloroquine alone had been used for treatment. There are also malaria treatment posts with trained staff in the towns and some active search for cases by surveillance agents. Voluntary collaborators at the schools and the surveillance agents take film and treat the patient at once. In the town malaria posts, a microscopist examines a blood film and the patient is treated only if parasites are found.

In 1947, before spraying began, ... 26 724 positive blood films were reported from a population of about 670 000. Species were found in the proportions 1 *P. malariae* : 108 *P. falciparum* : 117 *P. vivax*.

As a result of the measures described above both *P. falciparum* and *P. malariae* disappeared, and autochthonous cases were last reported in 1956 and 1961 respectively. However. *P. vivax* infections continued at a high endemic level in the northern part of the State. In the southern part of the State even *P. vivax* disappeared in many areas and was found only sparsely in others even in the absence of spraying.

The population now at risk is about 1 000 000.

The monthly incidence of *P. vivax* shows considerable stability as shown in Table 1. This gives the results of blood examinations made only in the town malaria posts of Santa Catarina State. As blood films are examined immediately in these posts, an accurate idea can be obtained of the monthly incidence of malaria among people attending them.

In the cold months May-September the figures in Table 1 almost certainly represent relapses only. This paper describes the results of surveys undertaken to find out if there were hidden reservoirs of infection in people who did not report for treatment but had malaria parasites in the blood.

FIELD TECHNIQUE

House-to-house visits were made and blood films taken from the total available population, excluding infants under three months of age, in places from which many infections had been reported. People away at work were searched for later, and only those residing temporarily outside the village were missing.

A very careful history was taken of past fever and treatment. Those found to have parasites in the blood at the first visit were asked at the second visit to seek treatment only if they developed symptoms of malaria. This was necessary as otherwise the natural reaction of people learning that they carried malaria parasites might have been to seek treatment irrespective of symptoms. Apart from this initial request they were encouraged to seek treatment as required. They were then visited at approximately monthly intervals and further blood films were taken in order to find out how long they continued to carry parasites without symptoms.

The work began in June 1962 and ended in December 1962 — i.e. it extended through the season of no or minimal transmission.

LABORATORY TECHNIQUE

All blood films were taken and examined by the same person (S.A.J.) and uniformity of thicknesse was attempted. Only thick films were used. After treatment with methylene blue they were stained with Giemsa's stain, 100 fields were examined, but to be counted as a field each had to be adequately stained and had to contain about 20 leucocytes as estimated at a glance. Fields with about 10 leucocytes were counted as half a field. In this way not less than 2000 leucocytes were seen in the course of an examination. To make a rough estimate of the parasite density it was arbitrarily assumed that the leucocyte count was always 8 000 per mm^3 and that therefore 0.25mm^3 of blood had been examined. Approximate total parasite densities and microgametocyte densities

were recorded. Macrogametocytes were not counted because of the difficulty of distinguishing them from mature trophozoites in thick films.

PLACES SURVEYED

1. Claraiba a village in the Município cf Nova Trento. Number of houses: 67. Population: 363, of which three were living away and two were infants under three months of age. Sprayed annually from 1949 to 1959 with the exception of the years 1951, 1955 and 1957. Not sprayed in 1960 or 1961.

2. Arraial (comprising Arraial, Arraial Central and Mina de Ouro), a village in the Município cf Gaspar. Number of houses: 73. Population: 552, of which eight were living away and five were under three month of age. Sprayed annually from 1949 to 1959 with the exception of 1955. Not sprayed in 1960 or 1961.

3. Boa Vista, a suburb that straggles several kilometres along a road from Joinville Town. All houses were visited for about half a kilometre. Number of houses: 43. Population: 254, of which three were living away from home and four were under three months of age. Sprayed annually since 1949.

Claraiba and Arraial extend for 6-7 kilometres in valleys between hills covered with primary forest containing many bromelias. They are typical villages of the malarious areas. Most houses are small and made of wood. They are usually at least 100 metres apart. Boa Vista lies within a kilometre of hills covered by primary forest containing many bromelias. There is also secondary forest with some bromelias between and behind the houses. The houses are small and mostly made of wood.

Unfortunately, Boa Vista is not strictly comparable with Claraiba and Arraial. However, it was the only place that could be found which had not missed spraying. In Claraiba and Arraial the people are in closer contact with the vectors as they work on plantations cut cut of primary forest. The people of Boa Vista are factory workers and their houses are less close to heavy concentrations of bromelias. The lower parasite rates should therefore be interpreted with caution.

In Claraiba and Arraial the people are peasant farmers working small-holdings. In Boa Vista they are labourers and factory workers, chiefly of Italian and German origin and have similar standards of living. They were very friendly and cooperative, and blood films were never refused. The impression gained was that treatment was unlikely to be sought on trivial grounds, particulary as blood films were taken.

According to the histories obtained, school treatment centres ("Notification Posts") and town Malaria Posts were found to be very popular. The number of people who reported seeking and receiving treatment for malaria from official sources in the 12 month preceding the survey was in follows Table 2.

TABLE 2

NUMBERS SEEKING TREATMENT IN YEAR PRECEDING SURVEY

Locality	Number treated	Percentage of population
Claraiba	47	33
Arraial	257	48
Boa Vista	117	19

The pattern seems to be that if people have fever which they think is malaria, they seek treatment at Post and give a blood film; however, if they are not sure of the diagnosis, they may seek treatment at the Post but often treat themselves with household remedies usually ineffective against malaria.

RESULTS

CLARAÍBA: General Results are shown in Table 3.

Only *P. vivax* parasites were found.

Of six infected households, four showed one parasite carrier per family; one contained two parasite carriers and one contained three parasite carriers. (Tables 4 and 5).

Of these nine cases, numbers four, seven and nine were found to be entered as positives in the official records for 1961 and 1962 to date of survey (Table 4).

164 (46 per cent.) of the population sought treatment for malaria from official sources during 1962. 73 (44 per cent.) of the blood films were positive; ie. 20 per cent. of the population had infections recorded officially during this year.

ARRAIAL: General Results are shown in Table 6.

Only *P. vivax* parasites were found.

In 14 infected households, eight showed one parasite carrier, and in six households two to five carriers were found.

Of the 25 parasite carriers found in Arraial, six (numbers four, eight, nine, 13, 15 and 18 in Table 7) had been entered as positive in the official records between January 1961 and the date of commencement of this work.

237 (44 per cent.) of the population sought treatment for malaria from official sources during 1962. 97 (39 per cent.) of the blood films were positive, i.e. 18 per cent. of the population had infections recorded oficcially during this year.

BOA VISTA: Results are shown in Tables 9 and 10.

Only *P. vivax* parasites were found.

Of three infected households, two were found to have one parasite carrier each, while in one house three parasite carriers were found.

Of these five cases, one (number one) had been entered as positive in official records for 1961 and 1962 to date of survey.

DISCUSSION

Of the 39 carriers of *P. vivax* studied in this series, eight per cent. gave no history of fever and 56 per cent. said they had fever thought to be malaria six or more month before; 36 per cent. reported malaria within the past six months; 31 (80 per cent.) had obtained treatment by chloroquine from one day to two years previously. It is not, of course, possible to say how long they had been carrying parasites before they were discovered in this survey. Actual observation showed that parasites could be found as often as six times out of seven at monthly intervals, so it seems likely that in at least some cases parasitaemia had already been present for some months.

Only one of the 39 parasite carriers had fever thought to be malaria close to the time of survey — the day before (Arraial, case number 22). This means that for one symptomatic parasite carrier there were 38 without symptoms in the population at the time of survey. As blood films were taken monthly it is not possible to be sure that parasitaemia was continuous, though this is indicated by what is known of the natural course of *P. vivax* infections (2). Moreover, when parasites are seen month after month it is unlikely that parasitaemias were occurring only on the day of the visit. Some people may well have been infective to mosquitos for much of the period of observation.

It is worth noting that quite low parasite rates were compatible with an appeciable incidence of malaria. The parasite rates in the two to nine age-group were four per cent. in Claraiba, and seven per cent. in Arraial and the official records showed an incidence of 20 per cent. and 18 per cent. of proved malaria in the village populations in the course of a year.

The tendency of *P. vivax* to relapse after treatment with chloroquine is very well

TABLE 3

CLARAIBA: PARASITE SURVEY 12-18 JUNE 1962

Age-group	Number examined	Number positive	Parasite rate
3/12-1	18	0	Nil
2-9	105	4	4%
10-15	54	2	4%
16-	181	3	2%
Totals	358	9	

TABLE 5

CLARAIBA — ANALYSES OF RESULTS GIVEN IN TABLE 4

Number of times positive at monthly visits	Number of persons	Number of treatments sought during period of observation	Number of persons
1	0	0	3
2	2	1	3
3	2	2	1
4	1	3	2
5	2		
6	2		
7	0		
Totals	9		9

TABLE 6

ARRAIAL — PARASITE SURVEY 19 JULY — 9 AUGUST 1962

Age-group	Number examined	Number positive	Parasite rate
3/12-1	22	0	Nil
2-9	180	11	6%
10-15	98	7	7%
16-	239	7	3%
Totals	539	25	

known, and chronic simptomless parasitaemias have usually been regarded as following untreated or inadequately treated symptomatic malaria no matter what drugs were used.

In this series there was a high incidence of *silent* relapse following adequate single dose treatment with chloroquine. We observed nine silent relapses after treatment with chloroquine of 13 cases which had had a symptomatic flare-up of parasitaemia: an incidence of approximately 70 per cent. of *silent relapses* following treatment. (Arraial case number 17 is not included as treatment was given only two days before our last visit.)

"Silent relapse" is used here to refer to the return of parasitaemia without symptoms recognizable as malaria by the patient, usually a month or more after an attack has been adequately treated to clear the blood of parasites. Re-infection in this series is very unlikely. However, asymptomatic new infections, if they occur, would be equally important from the epidemiological aspect.

We have no doubt that single treatment with 600 mg chloroquine for adults, and proportional doses for children, is adequate to clear the blood of local strains of *P. vivax*. We have followed up 170 cases treated with this dosage and found all blood films negative about 10-15 days after treatment.

In our series of silent relapses the parasites were seen at 29, 32, 33, 34, 35, 49, 51, 51 and 84 days respectively after treatment, but of course the exact day of reappearance of parasites is not known.

The discovery that *P. vivax* can relapse silently is not new. Yeung & Ciuca (1962) give clear evidence of this in Romania and say: "The ability of such long-term silent relapses in Romanian malarias to infect mosquitos needs to be known by those in charge of eradication programmes."

Shute & Maryon (5, 6) showed that 10 microgametocytes per mm^3 of blood was consistent with infection of mosquitos. They record nine bloods with microgametocytes in densities of 1:500 leucocytes (16 per mm^3 on the scale adopted by us) that infected an average of 53 per cent. of 180 mosquitcs fed on them in batches of 20. The average maximum number of oocysts in the most heavily infected mosquitos of each batch was nine. Infection could occur even when no microgametocytes were seen, though in the case quoted, out of 20 mosquitos fed cnly two became infected, each with a single oocyst. Absence of macrogametocytes when microgametocytes are present appears to be uncommon.

Shute & Maryon were working with a different vector and a different strain of *P. vivax*. We cannot with certainty extrapolate from their results to local conditions. The infectability potential of the vectors in Santa Catarina State is not known as *Kerteszia* mosquitos have never been sucessfully reared in captitivty. However, it seems advisable to assume that the lower densities found by us of 4-12 microgametocytes per mm^3 would be consistent with a low or medium capacity to infect mosquitos, and that densities of 16 or more would indicate a high capacity to transmit infection.

If we accept the above premise, then during the period of observation of our series of 39 cases, out of 206 blood examinations, microgametocytes in highly infective numbers were seen on nine occasions, and in low to medium infective capacity on 26 occasions. As indicated above it is impossible to believe that they were present only at the time of the blood collections.

The initial survey showed some particularly interesting proportions. For one symptomatic and highly infective case (Arraial, number 22), there were 38 symptomless parasite carriers of which four were potentially highly infective and six were of low or moderate infectivity. Table 1 indicates a fairly steady rate of symptomatic relapse throughout the winter months: it seems likely that the number of asymptomatic relapses is also maintained.

Symptomatic *P. vivax* infections, particulary relapses in semi-immune subjects, are often accompained by high parasiaemia and many gametocytes (5). They can therefore be expected to be highly infective to mosquitos while parasitaemia lasts. However free treatment is readily

TABLE 4

CLARAIBA — FINDINGS AT MONTHLY VISITS

Case Nº	Sex	Age	Time since last fever	Treatment	Date and approx. parasite densities per mm³ (Microgamet. counts entered below total parasites)						
					12/6-18/6	18/7	17/8	12/10	17/9	15/11	16/12
1	M	7	0		4 0	12 4	12 0	0	0	0	0
2	F	14	5 months 15 days	NP: 4 tab Pil	2200 (T) 48	0 (T)	0	2800 36	136 0	64 4	4 0
3	F	9	3 months	NP: 3 tab	560 12	400 4	40 4	36 0	144 (T) 4	0	8 0
4	F	8	2 months	NP: nil	4 0	0 (T)	0 (T)	0	0 (T)	0	1120 52
5	F	19	4 days	Pil	832 16	560 (T) 16	0	0	0	0	0
6	M	6	5 months	NP: 2 tab	320 12	16 4	40 4	400 4	0	32 8	8 0
7	M	44	7 months 15 days	NP: 4 tab Pil	16 0	428 (T) 12	0 (T)	0	200 (T) 4	0	24 0
8	F	46	1 year	Pil	2 0	160 (PT) 8	176 16	272 0	25 4	0	0
9	F	15	6 months 2 days	NP: 3 tab Pil	2 0	8 0	2 0	0	0	0	0

NP: treated at Notification Post with chloroquine. Each "tab" is 150 mg base.
Pil treated at home with household remedy (usually "Vinte e Um" pills, a proprietary febrifuge) without value against malaria.
PT treated at home with mepacrine in inadequate dosage (4 tablets).
(T) treated at NP since previous visit, with full single dosage.
(T) blood film taken at NP at time of treatment found positive.

available at the village school, and this may me sought very early. We met one woman on her way to get treatment while still having rigors. If we include the pre-clinical parasitaemia of a true symptomatic relapse (as opposed to a flare-up of an asymptomatic parasitaemia), the total time available for infecting mosquitos is only about six days. By contrast, silent cases can carry their parasites for months. Because of this time factor it is not possible to compare the relative importance of symptomatic and asymptomatic parasite carriers as sources of infection.

However, a little arithmetic shows that very few symptomless parasite carriers constantly present would add up to a great many infective man-days. For one highly infective symptomatic case, Claraiba and Arraial produced four potentially highly infective and six low to moderately infective cases at the initial survey. Official records show 170 blood positive cases of malaria in the two villages during 1962. At the somewhat generous estimate of six days' infectivity for each of these symptomatic cases, this would give a total of 1020 infective man-days during the year. By contrast only four infective asymptomatic carriers present constantly during the same period would give a total of 1460 infective man-days. If we assume all 10 symptomless gametocyte carriers to be infective we find a total of 3650 infective man-days. In thinking in terms of depth in this way it is necessary to remember that in the situation described the symptomless carriers would no always be the same persons. Some infections would die out but would be replaced by others as new relapses occurred.

Infectivity by mosquitos is not only dependent on the number of gametocytes present in their blood meals. Other factors of importance in transmission are the number of vectors biting, the prevailing temperature and humidity, the average length of life of the vectors under natural conditions, and whether they are exposed to any peril from insecticides. In the area described, peasants after working on their cultivations rest or may take lunch in forest shade where the vectors bite very freely. Catches on human bait can be as high as several hundred per hour. It is probable tha many people have a favourite spot for resting to which they return day by day. Such places are likely to be dangerous foci of infection.

Although *Kerteszia* mosquitos readily invade houses, specially at night, they are also notoricusly exophagous. Rachou & Ferreira (1947) used the following praphic words: "They attack man voraciously at any time of the day or night. Innumerable times when carrying out studies of larvae in the woods or in their proximity, we were attacked by great clouds of anophelines of this sub-genus."

These exophagous habits reduce the effectiveness of house spraying with DDT though this is thought to have some effect as there was a sharp increase of malaria reported in the State as a whole following a reduction of spraying in 1960 and 1961.

In years during which spraying has been at normal levels the incidence of reported malaria remains remarkably stable. It seems probable that in such years the level of malaria has been pushed down to a certain point at which it is held by outdoor transmission and the frequency of infective relapses, both symptomatic and asymptomatic, that follow treatment of *P. vivax* infections with chloroquine.

In considering the efficiency of the measure adopted and the skill shown in their application, it is necessary to recollect that they were adequate to achieve the considerable success of eradicating authochthonous infections of *P. falciparum* and *P. malariae* from the State.

The absence of spraying in Claraiba and Arraial during 1960 and 1961 may well have meant that we were dealing with a somewhat higher level of malaria than normal in their populations. It is difficult to believe that the basic proportions of symptomatic to asymptomatic infections would be much affected.

It is evident that *P. vivax* has been in balance with the forces used against it — i.e. spraying and prompt treatment of cases with chloroquine. It is therefore necessary to consider ways in which this ba-

TABLE 7

ARRAIAL — FINDINGS AT MONTHLY VISITS

Case Nº	Sex	Age	Time since last fever	Treatment	Date and approx. parasite densities per mm³ (Total parasites/microgametocytes)									
					19/7-9/8		10/9		13/10		12/11		15/12	
1	M	17	1 year	NP: 4 tab	4/0	(T)	0		0		4/0		0	
2	M	12	1 month	NP: 2 tab	4/0	(*T*)	0		0		0	(T)	0	
3	F	19	2 years	NP: 2 tab	8/0		0		0		0		0	
4	F	4	9 months	NP: 1 tab	640/8		32/0		400/16		64/0		320/0	
5	M	6	18 months	G: 2 tab	28/0		24/0		0		12/0		8/0	
6	F	6	Never ("grippe" 1 week ago)	Pil	32/0		0		32/0		0		0	
7	F	5	2 years ("grippe" 2 months)	NP: 1 tab Pil	480/0		8/0		24/0		0		0	
8	M	11	18 months	NP: 2 tab	24/0		4/0		0		0		4/0	
9	F	6	11 months	NP: 1 tab	48/0		0		0	(T)	0		0	
10	F	35	4 months	Pil	4/0		0		0		0		0	
11	F	10	3 months	NP: 2 tab	12800/88	(T)	0	(*T*)	0		0		0	
12	F	31	8 months	NP: 2 tab	12/0		0		0		0		0	
13	F	11	4 months	NP: 2 tab	4/0		0		0	(T)	20/0		4/0	
14	M	8	11 months	NP: 1 tab	68/0		80/0		0		0		0	
15	M	5	10 months	NP: 1 tab	920/16	(*T*)	0	(*T*)	0	(T)	0		80/4	
16	F	6	10 months	NP: 1 tab	40/0		0		0	(T)	0		0	
17	M	3	11 months	NP: 1/2 tab	32/0		48/0		0		32/0	(T)	12/4	
18	F	17	5 months	NP: 2 tab	32/0	(*T*)	20/0		32/0		32/0		0	
19	F	11	2 months	G: 2 tab	480/0		44/0		720/0		0		640/8	
20	F	7	2 months	G: 2 tab	32/4		2240/0		80/0		200/4		320/0	
21	M	9	2 months	G: nil	240/4		12/0		4/0		32/0		64/0	
22	F	20	1 day	NP: 4 tab	9360/40	(T)	480/8		4/0		24/0		4/0	
23	F	13	6 months	NP: 3 tab	400/8		616/0		400/0		240/0		48/0	
24	M	10	1 year	NP: 2 tab	4/0		0		0		0		0	
25	F	20	1 year	NP: 4 tab	4/0		0		0		4/0		0	

NP: treated at Notification Post with chloroquine. Each "tab" is 150 mg base.
G: treated by a surveillance agent on active search for cases.
Pil treated at home with household remedy.
(T) treated with chloroquine at full single dosage since previous visit.
(*T*) blood film taken at NP time of treatment found positive.

lance could be upset. The follcwing methods could supplement spraying and chloroquine treatment of attacks:

(1) Radical treatment with primaquine can be given to all proved cases of malaria. The National Malaria Service (CEM) is already testing this method on Santa Catarina island with very good results.

The main hope for this method lies in the comparative inefficiency of the vectors, cr the low gametocyte densities present, and the long season of no transmission during which parasite carriers can be found and cured. Success depends upon so depleting the reservoir of parasite carriers that the vectors would be unable to re-establish the original parasite rates during the next transmission season. If the number of cases then occurring were reduced substancially, there would be the possibility that this trend could continue year by year until eradication would be achieved. This might be likened to a war of attrition. It is most likely to succeed where the existing reservoir is small and the situation of *P. vivax* is precarious. Santa Catarina island and the adjacent mainland form the southern limits at which malaria has remained a formidable problem in the State. What works well there may not have the same value further north but it is certainly worth trying. In the village areas described in the paper the proportion of four potentially highly infective and six potentially moderately infective symptomless carriers to one symptomatic patient, and the frequency of multiple infections in families, could constitute an obstacle to success. This latter epidemiological factor appears in our records: in 39 per cent of the 23 infected households more than one person was infected, the range being two to five parasite carriers. Thus if one symptomatic person receives radical treatment he may thereafter be exposed to re-infection from asymptomatic sources within his own family. The number of staff required for distribution of the treatment would also be a problem.

(2) If radical treatment of discovered cases proves to be unsatisfactory, it would clearly be necessary to take measures against the symptomless parasitaemias. The most practical first step would be to take blood films from all members of a family in which one person has been found infected. At some levels of endemicity this might turn the balance as a substantial portion of the parasitic reservcir could thus be found and given radical treatment. Mass blood examinations, by contrast, are unlikely to yield results commensurate with the expense and effort involved as many low density infections would be missed and many persons would show no parasite but would still be subject to later relapse.

Alternatively distribution of drugs to the whole population might be attempted, either by using medicated salt of by periodic mass treatment with a combination of 4- and 8-aminoquinolines. This might be likened to total warfare against the parasite. Unfortunately it would be very expensive and the mass distribution of tablets is accompanied by many known difficulties.

(3) Another approach that might be well worth trying would be the distribution cf medicated salt only to the families of known positive cases. This could be limited to the duration of the transmission season and local schools could be used as depots for the distribution of the salt. The cost of the medicated salt migth at first be high but this would be off-set by the fact that few extra staff would be required and no extra blood films would need to be examined. However, it would be necessary to make a careful epidemiological investigation of every infection encountered in families taking the salt to ensure that if persistent strains of parasite occur they are quickly recognized and to determine the origin of infections if possible. The same applies, of course, should medicated salt be used to cover the total population of problem areas, or any other medication at present knwon to science.

Before our work was carried cut the National Malaria Service (CEM) had already planned a medicated salt experiment. This work and the experimental distribution at intervals of a combination of 4- and 8-aminoquinolines has recently been completed.

TABLE 8

ARRAIAL — ANALYSIS OF RESULTS GIVEN IN TABLE 7

Number of times positive at monthly visits	Number of persons	Number of treatments sought during period of observation	Number of persons
1	8	0	15
2	5	1	7
3	3	2	2
4	4	3	1
5	5		
Totals	25		25

TABLE 9

BOA VISTA — PARASITE SURVEY 23—26 AUGUST 1962

Age-group	Number examined	Number positive	Parasite rate
3/12-1	14	0	Nil
2-9	74	2	3%
10-15	33	1	3%
16-	126	2	1.5%
Totals	247	5	

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RESUMO

Até 1948, quando foi aplicado um método que associava a pulverização das casas com DDT e a instalação de postos de tratamento em tôdas as escolas rurais, o litoral do Estado de Santa Catarina, no Brasil, foi altamente malarígeno. A aplicação dessas medidas provocou o desaparecimento das infecções por P. falciparum *e por* P. malariae, *cujos últimos casos autoctones datam, respectivamente, de 1956 e 1951. Entretanto, na parte setentrional dêsse território, as infecções por* P. vivax *permaneceram com endemicidade elevada.*

O presente trabalho expõe os resultados dos inquéritos feitos com a finalidade de encontrar reservatórios inaparentes, entre os habitantes que não procuravam tratamento. Tôdas as casas foram visitadas e, com exceção das crianças de menos de três meses, foram tomadas gotas espessas de sangue de tôda a população acessível (1 144). Os indivíduos portadores de parasitas foram controlados, por visitas mensais ao domicílio, de junho a dezembro de 1962, até o aparecimento dos sintomas.

Trinta e nove portadores assintomáticos de P. vivax *foram acompanhados durante quatro a seis meses, fora da época de transmissão; o exame mensal das gotas espessas mostrou que a parasitemia pode perdurar por vários meses.*

Em treze indivíduos observou-se uma recaída com sintomas. Todos êsses casos foram tratados com cloroquina (600mg para os adultos e doses proporcionalmente reduzidas para as crianças) e, dentre êles, nove tiveram recaídas assintomáticas durante o tempo de observação, o que dá um índice de recaídas assintomáticas de cêrca de 70%.

Um dêsses indivíduos apresentou sintomas atrabuíveis ao paludismo em data muito próxima do inquérito inicial (na véspera). Dentre os outros trinta e oito portadores assintomáticos de parasitas, a densidade de microgametócitos fazia supor que o potencial de infectibilidade para os mosquitos vetores, era alta em quatro casos e fraca ou moderada em seis.

Haveria assim, dez portadores assintomáticos potencialmente infectantes, para cada caso de malária sintomática. Tendo-se em conta o fato de que, na área estudada, as pulverizações não são capazes de eliminar totalmente a transmissão do paludismo, as pessoas que se encontram nessas condições, sem sentir necessidade de procurar tratamento, podem constituir uma fonte de infecção importante. Torna-se, portanto, necessário procurar métodos que permitam contornar essa situação.

RESUMÉ

La zone côtière de l'Etat de Santa Catarina, au Brésil, a été fortement impaludée jusq'au moment où l'on a appliqué une méthode associant les pulvérisations de DDT et l'organisation du traitement dans toutes les écoles rurales. Ces mesures ont eu pour résultat la disparition des infections à P. falciparum *et à* P. malariae, *dont les derniers cas indigènes signalés remontent à 1956 et 1951 respectivement. Cependant, l'infection à* P. vivax *a gardé un degré élevé d'endémicité dans la partie septentrionale du territoire.*

Le document WHO/Mal/469 expose les résultats des enquêtes que l'on a faites pour déterminer s'il existait des réservoirs dissimulés d'infection parmi les habitants qui ne s'étaient pas présentés pour se faire traiter. Des tournées porte à porte ont été organisées et l'on a fait sur toute la population accessible (1144), à l'exception des enfants de moins de trois mois, des prises de sang pour examen des étalements. Les sujets présentant des parasites on été contrôlés à domicile chaque mois, de juin à décembre 1962, jusqu'à l'apparition des symptômes.

Trente-neuf porteurs asymptomatiques de P. vivax *on été suivis pendant quatre à six mois en dehors de la saison de transmission; l'examen mensuel des étalements de sang a montré que la parasitémie peut persister pendant de nombreux mois.*

Chez treize de ces sujets, on a observé une rechute avec symptômes; ils ont été traités à la chloroquine (600 mg pour les adultes et doses propor-

TABLE 10

BOA VISTA — FINDINGS AT MONTHLY VISITS

Case Nº	Sex	Age	Time since last fever	Treatment	Date approx. parasite density per mm³ (Total parasites/microgametocytes)				
					23/8-26/8	24/9	23/10	28/11	28/12
1	M	16	8 months	G: 4 tab	56/0	0	0	0	0
2	M	48	1 year	G: 10 tab	8/0	0	0	0	0
3	M	12	8 years	NP: 5 tab					
4	M	3	Never						
			("grippe"		280/0	0	8/0	0	0
			1 month)	Pil	56/0	0	16/0	0	16/0
5	M	2	6 months	NP: 2 1/2 tab	320/0	400/4	64/4	400/4	66/4

NP: treated at Notification Post with chloroquine. Each "tab" is 150 mg base.
G: treated by a surveillance agent on active search for cases.
Pil: treated at home with household remedy.

tionellement réduites pour les enfants) et neuf d'entre eux ont fait une rechute sans symptômes alors qu'ils étaient en observation: le taux de ces rechutes sans symptômes s'établit donc à 70% environ.

L'un des sujets présentait des symptômes imputables au paludisme à une date très voisine de celle de l'enquête initiale (la veille). Parmi les trente-huit autres porteurs asymptomatiques de parasites, les densités de microgamétocytes laissaient supposer que le potentiel d'infectiosité pour les moustiques vecteurs était élevé dans quatre cas et faible ou modéré dans six cas.

Pour un cas symptomatique de paludisme, il y a avait donc dix porteurs asymptomatiques susceptibles d'être infectants. Les personnes se trouvant dans ce cas, ne ressentant pas le besoin de se faire traiter, peuvent constituer un important réservoir d'infection lorqu'il n'est pas possible d'éliminer totalement les vecteurs par des pulvérisations. Il est donc nécessaire de trouver d'autres moyens d'agir en pareilles circonstances.

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