MALARIA SITUATION IN SEVERAL VILLAGES AROUND TIMIKA, SOUTH CENTRAL IRIAN JAYA, INDONESIA

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Abstract. Malaria in Timika area, south central Irian Jaya, is a public health problem causing morbidity and mortality, particularly to the vulnerable age group. In August/September 1992 malariometric surveys were conducted simultaneously with sensitivity studies of *Plasmodium falciparum* to antimalarials, and bionomics of vectors in six villages around Timika (Mwapi, Kaugapu, Hiripau, Pomako, Mapurujaya, Kwamki Lama). The average overall spleen rate was 44.0%, the highest rate observed in Kwamki Lama (68.3%) and the lowest in Mapurujaya (13.7%). The average parasite rate in children aged 2-9 years was 60.6%. The highest rate was found in Mwapi (92.0%) and the lowest rate in Mapurujaya (4.8%). In the study area the dominant species was *P. falciparum*, (except in Kaugapu), followed by *P. vivax*. *P. malariae* and *P. ovale* were not observed.

In vivo sensitivity studies done in 7 villages showed *P. falciparum* was resistant to chloroquine [51.3% S/R I (sensitive or I[st] grade resistant), 43.6% R II and 5.1% R III] in Kwamki Lama, SP I and SP II (transmigrant settlements) and Timika health service center. *In vitro* sensitivity test in Kwamki Lama, SP I, SP II and Timika health service center showed 64.4% resistant to chloroquine, and remain sensitive to sulfadoxine-pyrimethamine, quinine and mefloquine.

Vector studies revealed that *Anophelese punctulatus* and *An. koliensis* were the potential vectors as was confirmed by ELISA positive test with a sporozoite rate of 1.43% and 0.33% respectively. The vectors were indoor and outdoor resting.

INTRODUCTION

Malaria is still one of the major public health problems in Indonesia, especially in the eastern part of Indonesia. In Irian Jaya, Metselaar (1961) reported that the area was holoendemic in some inland plains, hyperendemic in some coastal areas and in mountainous areas with an altitude of < 1,600 m, and mesoendemic in the corral islands offshore. In the central high mountains above 1,600 m there was no malaria. Of the four human species of malaria parasites identified in Irian Jaya, *Plasmodium falciparum* and *P. vivax* were the most common parasites, *P. malariae* was uncommon, and *P. ovale* has been found on Owi Island and elsewhere (Djuanda and Dennis, 1977).

In 1975, results of malariometric surveys along the coast of Irian Jaya showed that the overall parasite rate varied from 1.4% (in Merauke) to 39% (in Abepura) as was reported by the Provincial Health Service (Gunawan, 1985). Resistance of *P. falciparum* to pyrimethamine and proguanil was first reported in 1961 by Meuwissen and resistance of chloroquine was suspected for the first time (Meuwissen, 1964). In 1975 Verdrager and Arwati reported 3 cases with an R I level resistance. Shortly after that, cases with R III resistance were detected (Ebisawa and Fukuyama, 1975a) followed by more reports with various levels of resistance (Ebisawa and Fukuyama, 1975a,b); Ebisawa *et al* (1976); Clyde *et al* (1976); Soegiarto *et al* (1977); Hutapea (1979); Dimpudus *et al* (1981); Hoffman *et al* (1984); Baird *et al*, (1991).

Vectors of malaria in Irian Jaya have been investigated by various workers since 1955. Of the various *Anopheles* species, the important malaria vectors are *An. punctulatus, An. koliensis, An. farauti, An. longirostris, An. karwari, An. bancrofti* (Van Thiel and Metselaar, 1955; Van den Assem 1959; Sloof, 1962). The aim of the preliminary investigation was to collect base line data on malariometric indices, vector biting habits, envi-

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ronmental conditions in the study area. Afterwards the data obtained would be used to organize malaria control strategies based on community parti cipation in a longitudinal study.

This paper only describes biomedical studies (1992-1993) about the prevalence of malaria in the first year, sensitivity studies of *P. falciparum* to antimalarials, and vector identification and bionomics of this area.

MATERIALS AND METHODS

Study site

The Timika area, in the south central part of Irian Jaya, is considered as hyperendemic for malaria, and was selected for study. The location of the villages was in the vicinity of Timika and along the main road about 60 km south of Timika, between 136° 45' - 137° 00 east longitude and 4° 45' - 5° 00 south lattitude, in east Mimika subdistrict, Fak-Fak district (Fig 1). The majority of the study group consisted of local inhabitants in the villages Kwamki Lama, Mwapi, Mapurujaya, Kaugapu, Hiripau and Pomako, and the transmigration settlements SP I and SP II.

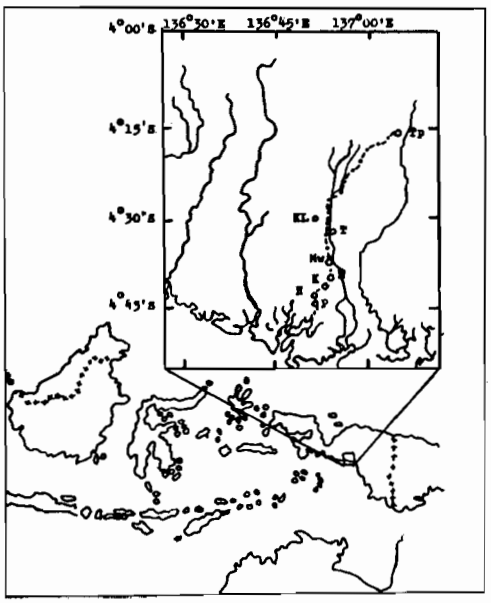

Fig 1–Surveyed villages around Timika south central Irian Jaya.
Tembagapura (Tp), Kwamki Lama (KL), Timika (T), Mwapi (Mw), Mapurujaya (M), Kaugapu (K), Hiripau (H), Pomako (P).
–•– –•– Main road, ——— river

The village of Kwamki Lama was developed by PT Freport Indonesia Co in Tembagapura Irian Jaya in the beginning of 1985 as resettlement for indigenous people from Waa Village in the mountainous area near the mining areas. These people consists of several tribes and are non-immune to the malaria disease endemic in the lowlands where Kwamki Lama is settled. Mapurujaya, located in a malaria endemic area, is inhabited mostly by newcomers who are originally from non-endemic areas and who are economically better off than the local people. The villages Mwapi, Kaugapu, Hiripau and Pomako are located in a coastal zone and highly endemic for malaria where the inhabitants have developed acquired immunity against malaria from years of exposure.

Biomedical studies

From August 31 to September 11, 1992 at the clinical and malariometric studies were conducted in 6 villages (Mwapi, Kaugapu, Hiripau, Pomako, Mapurujaya and Kwamki Lama), while sensitivity studies were done in Kwamki Lama, Timika Health Service Center, SP I, SP II, Mapurujaya, Kaugapu and Hiripau.

Data were collected from physical and blood examinations for detection of fever, spleen enlargements and malaria parasites. Spleen enlargements were classified according to Hackett's method (Bruce-Chwatt, 1980).

Venous blood (7 cc) was drawn from each subject for:

1) malaria parasite examination with the conventional Giemsa staining method (Bruce-Chwatt, 1980.
2) *in vivo* sensitivity test to chloroquine and also *in vitro* to other antimalarials.

Qualitative tests for the presence of 4-aminoquinolines and sulfonamides in the urine were conducted according to the Dill-Glazko and Iiguin methodology (Bruce-Chwatt, 1981). A positive urine test excluded participation in the study.

In vivo sensitivity test was conducted according to the simplified WHO standard 7-day field test and *in vitro* test to the WHO micro test method. The drug administered for the *in vivo* test was the uncoated Resochin® tablet (Bayer) containing 250 mg chloroquine phosphate, equivalent to 150 mg chloroquine base.

Vector studies

Vector studies were conducted in Mwapi, Kaugapu, Hiripau, Pomako and Kwamki Lama from September to November 1992 at the end of the rainy season. Mosquitos were collected indoors as well as outdoors during the night. ELISA was used to detect sporozoites in the adult mosquitos (Burkot and Wirtz, 1986).

RESULTS

Malariometric studies

A total of 1,068 local inhabitants of villages around Timika were examined between 31 August and 11 September, 1992 at the end of the rainy season. Malariometric results from 6 villages, showed an overall spleen rate between 13.7% and 68.3% with an average of 44.0%. The spleen rate between 2 - 9 years of age varied between 4.8% and 92.0% with an average of 60.6% (Table 1). The level of endemicity varied between hypoendemic (Mapurujaya) and holoendemic (Mwapi), based on spleen enlargement.

The results of parasite examination is shown in Table 2. The overall parasite prevalence was between 11.8 and 41.6% with an average of 26.1%. The parasite rate of children between 2 - 9 years old was between 14.3 and 64.0% with an average of 40.4%.

Parasite species found in the study villages was the predominant *Plasmodium falciparum* followed by *P. vivax* with a formula of 77.1% for *P. falciparum* and 29.7% for *P. vivax*. *P. malariae* and *P. ovale* were not detected (Table 3).

Results of *in vivo* studies of *P. falciparum* to chloroquine with the simplified 7-day field method showed 5.1% R III type resistant in transmigrant villages (SP I and SP II) and in Kwamki Lama. R II resistance was found in 43.6% of falciparum malaria cases and the remaining 51.3% was still sensitive or R I resistant (Table 4). There were 5 drop out cases (6.0%) because they could not be followed up.

In vitro sensitivity studies of *P. falciparum* to chloroquine and other antimalarials revealed 64.4% out of 76 cases examined were resistant to chloroquine but still sensitive to S-P (sulfadoxine-pyrimethamine), quinine and mefloquine (Table 5).

Results of vector studies revealed mosquitos collected in the above mentioned villages were *An. punctulatus* (53.43%), *An. koliensis* (45.95%), *An. farauti* (0.46%) and *An. longirostris* (0.15%). Night collections (outdoors and indoors) produced ELISA positive of *P. falciparum* in *An. punctulatus* (2.78%) and of *P. vivax* in *An. koliensis* (0.34%). *An. farauti* and *An. longirostris* have so far not shown its role as vectors, probably due to its low population density.

The biting activity of *An. punctulatus* and *An. koliensis* in 4 villages in October - November 1992 were between 21.00 and 02.00 hours, and between 22.00 and 03.00 hours with an MBR of 6.00 and 8.67 respectively. The EIR of *An. punctulatus* was 0.167 and of *An. koliensis* 0.166.

DISCUSSION

Malariometric data from children of 2 - 9 years as reported by Lee *et al* in 1980, revealed that the spleen rate in Kwamki was 97% (38/39), in Timika 85% (12/14) and in Mapurujaya 97% (106/109). In the present study, malariometric results from 6 villages around Timika (Table 1) showed an average spleen rate (in children of 2 - 9 years) of 60.6%. The highest spleen rate was seen in Mwapi (92.0%) and in Kwamki Lama (80.4%). The lowest was in Mapurujaya (4.8%) which was in contrast with the findings of Lee *et al* (1980). In Mwapi, the majority of the inhabitants being fishermen and of the Komoro tribe, periodically left the village - many times with the whole family - to the coastal areas by small boat from the nearby river and stayed for weeks to catch fish for their living. During these trips they were more exposed to malaria vectors because they were sleeping in open temporary tents, although their own houses in Mwapi were not 100% mosquito proof. On the contrary, the inhabitants of Kwamki

Table 1

Spleen prevalence in 6 villages around Timika, south central Irian Jaya, by year age groups, August/September 1992.

Age group (yrs)	Mwapi	Kaugapu	Hiripau	Pomako	Mapuru-jaya	Kwamki Lama	Total
> 1	0 (0/4)	11.1% (1/9)	30.8% (4/13)	50.0% (3/6)	20.0% (1/5)	50.0% (3/6)	27.9% (12/43)
1 - < 2	40.0% (2/5)	50.0% (5/10)	37.5% (3/8)	66.7% (2/3)	16.7% (1/6)	25.0% (2/8)	37.5% (15/40)
2-4	90.9% (10/11)	39.5% (15/38)	47.8% (11/23)	70.0% (21/30)	8.3% (1/12)	77.8% (21/27)	56.0% (79/141)
5-9	92.9% (13/14)	52.4% (22/42)	65.9% (27/41)	76.9% (20/26)	0 (0/9)	84.2% (16/19)	64.9% (98/151)
10-14	65.0% (13/20)	56.5% (26/46)	64.3% (27/42)	70.0% (14/20)	28.6% (4/14)	84.2% (16/19)	62.1% (100/161)
≥ 15	50.9% (27/53)	22.3% (29/130)	28.8% (40/139)	13.2% (9/68)	12.5% (7/56)	63.5% (54/85)	31.3% (166/531)
Overall spleen rate	60.7% (65/107)	35.6% (98/275)	42.1% (112/266)	45.1% (69/153)	13.7% (14/102)	68.3% (112/164)	44.0% (470/1,067)
Spleen rate (2-9 yrs)	92.0% (23/25)	46.3% (37/80)	59.4% (38/64)	73.2% (41/56)	4.8% (1/21)	80.4% (37/46)	60.6% (177/292)

Table 2

Parasite prevalence in 6 villages around Timika in south sentral Irian Jaya by year age groups, August/September 1992.

Age groups (yrs)	Mwapi	Kaugapu	Hiripau	Pomako	Mapuru-jaya	Kwamki Lama	Total
< 1	25.0% (1/4)	0 (0/10)	61.5% (8/13)	33.3% (2/6)	0 (0/5)	16.7% (1/6)	27.3% (12/44)
1 - < 2	80.0% (4/5)	77.8% (7/9)	62.5% (5/8)	66.7% (2/3)	28.6% (2/7)	50.0% (4/8)	60.0% (24/40)
2-4	90.9% (10/11)	28.9% (11/38)	60.9% (14/23)	46.7% (14/30)	15.4% (2/13)	50.0% (14/28)	45.5% (65/143)
5-9	35.7% (5/14)	32.6% (14/43)	37.5% (14/40)	38.5% (10/26)	12.5% (1/8)	45.0% (9/20)	35.8% (54/151)
10-14	23.8% (5/21)	31.9% (15/47)	22.7% (10/44)	30.0% (6/20)	0 (0/14)	50.0% (10/20)	27.7% (46/166)
≥ 15	11.5% (6/52)	10.8% (14/130)	15.2% (21/138)	14.7% (10/68)	12.3% (7/57)	36.9% (31/84)	17.1% (89/521)
Overall parasite prevalence	29.0% (31/107)	22.0% (61/277)	27.4% (73/266)	28.8% (44/153)	11.5% (12/104)	41.6% (69/166)	27.0% (290/1,073)
Parasite rate (2-9 yrs)	60.0% (15/25)	30.9% (25/81)	46.0% (29/63)	42.9% (24/56)	14.3% (3/21)	47.9% (23/48)	40.5% (119/294)

Table 3

Parasite species and frequency in six villages around Timika, south central Irian Jaya, August/September 1992.

Village	Species			Total	Frequency	
	P. falciparum	*P. vivax*	Mixed infection		*P. falciparum*	*P. vivax*
Mwapi	25	1	5	31	96.8% (30/31)	19.4% (6/31)
Kaugapu	45	8	2	55	85.5% (47/55)	18.2% (10/55)
Hiripau	59	9	2	70	87.1% (61/70)	15.7% (11/70)
Pomako	26	11	5	42	73.8% (31/42)	38.1% (16/42)
Mapurujaya	12	0	0	12	100% (12/12)	0
Kwamki Lama	29	35	5	69	49.3% (34/69)	58.0% (40/69)
Total	196	64	19	279	77.1% (215/279)	29.7% (83/279)

Table 4

In vivo sensitivity test of *P. falciparum* to chloroquine using the simplified 7-day field around Timika, south central Irian Jaya, August-October 1992.

Village	N	F	Successful test	*In vivo* sensitivity test		
				S/R I	R II	R III
Kwamki Lama	35	2	33	16 (48.5%)	15 (45.5%)	2 (6.0%)
Puskesmas Timika	27	0	27	13 (48.1%)	14 (51.9%)	0
S P I	1	0	1	0	1 (100%)	0
S P II	7	0	7	3 (42.8%)	2 (28.6%)	2 (28.6%)
Mapurujaya	1	0	0	1 (100%)	0	0
Kaugapu	9	3	6	5 (83.3%)	1 (16.7%)	0
Hiripau	3	0	3	2 (66.7%)	1 (33.3%)	0
Total	83	5	78	40 (51.3%)	34 (43.6%)	4 (5.1%)

N = number examined, F = number of failures, S = number and % sensitive, R = number and % resistant.

Lama were from other tribes (*eg* Dani, Dauga, Me, Ekari, Amungme) resettled from villages in the high mountainous areas around the copper mines of Tembagapura where there is no malaria transmission. Therefore, they were less immune to the disease. In Mapurujaya however, the village where the office of the Government administration is located, the majority of the inhabitants were newcomers from Java, Sumatra, Sulawesi, and Maluku. Their houses were mostly mosquito free, and their habit was also different compared to the native people, for example they would not stay outside houses until late at night. The economic situation was considered much improved compared to that of 12 years ago.

The average child parasite rate however, was only 40.4% (Table 2), between 60.0% in Mwapi and

Table 5

In vitro sensitivity test of *P. falciparum* to chloroquine, S-P, quinine, and mefloquine around Timika, south central Irian Jaya, August/October 1992.

Village	*In vitro* test											
	chloroquine			S-P			quinine			mefloquine		
	N	F	R	N	F	R	N	F	R	N	F	R
Kaugapu	7	5	0	6	4	0	6	4	0	6	4	0
Hiripau	1	0	1 (100%)	1	0	0	1	0	0	1	0	0
Mapurujaya	1	0	0	1	0	0	1	0	0	1	0	0
KwamkiLama	37	8	17 (58.5%)	33	8	0	33	11	0	35	14	0
Puskesmas Timika	23	2	17 (81.0%)	21	4	17	17	6	0	23	5	0
SP I	1	0	1 (100%)	1	0	0	1	0	0	1	0	0
SP II	6	2	3 (75.0%)	6	2	0	6	2	0	6	2	0

14.3% in Mapurujaya. In Kwamki Lama it was 47.9%. A similar result was also observed by Lee et al (1980) (52% in Kwamki, 38% in Timika), but 46% in Mapurujaya which was controversial with the present result in Mapurujaya as was the spleen rate. It could be explained that Mapurujaya at the time of Lee *et al*'s survey (1980) was only inhabited by natives, while during this survey they were almost all newcomers.

In endemic areas, splenomegaly and parasite prevalences are usually highest in children less than five years of age. In a study by Al-Yaman *et al* (1995) in Papua New Guinea, both reached a peak in those 5 - 10 years of age. In Timika area, the spleen rates were quite high in children until the age of 14 years in all villages, except in Mapurujaya, whereas parasite prevalences were prominent in underfive years age group, except Kwamki Lama and Mapurujaya. This survey was conducted at the end of the transmission season where villagers were at the stage of high risk infection. This was reflected by a high infant parasite rate in several villages, and high spleen rate in every age group in Kwamki Lama and Mwapi.

Parasite rates were found lower than spleen rates. This could be explained as parasite rates represented only infections occurred during the period of blood collection, indicating a point prevalence of parasite infection, while spleen enlargements measured to obtain spleen rates were more stable for a longer period of time.

In vivo sensitivity studies showed resistance of *P. falciparum to* chloroquine with a percentage of at least 48.7% (R II and R III) in Timika area in south central Irian Jaya, compared to 54% resistance in Arso PIR in northeast Irian Jaya of which 53.7% (29/50) were R II and R III which was reported in 1991 (Baird *et al*). In this study all chloroquine resistant cases were cured with S-P (sulfadoxine-pyrimethamine).

In vivo RI resistant cases of *P. falciparum* to S-P were reported in 1979 from Jayapura area (Hutapea, Rumans). In 1987 Hoffman *et al* reported two low grade (R I) S-P resistant cases from Jayapura, northeast Irian Jaya and concluded that S-P was still an effective antimalarial for most patients with falciparum malaria in Jayapura.

In vitro sensitivity results revealed *P. falciparum* was only resistant to chloroquine (64.4%), and still sensitive to S-P, quinine and mefloquine. It could be assumed that this study area is still monodrug resistant, compared to *in vitro* studies carried out in Dili area, east Timor and Balikpapan area, east Kalimantan, which were already multidrug resistant (Pribadi, 1992). From Jayapura, northeast Irian Jaya, 7 *in vitro* chloroquine resistant malaria falciparum cases at 48 hours incubation were reported (Hofmann *et al,* 1983). In addition, five cases of *P. falciparum* infection in Jayapura, were

also reported to be *in vitro* resistant to quinine and to mefloquine, a new antimalarial not available in Indonesia (Hoffman *et al,* 1983).

Findings of vector studies were similar with vector studies in Timika area reported by Lee *et al* (1980) who described the presence of *An. koliensis* and *An. punctulatus* as being most abundant with few *An. farauti,* and no *An. longirostris.* One specimen of each of the first two species was positive with sporozoites in thoracic tissue upon dissection (Lee *et al,* 1980).

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