A REVIEW OF THE MALARIA SITUATION IN IRIAN JAYA *

Suriadi Gunawan[1]

ABSTRAK

Karangan ini merupakan tinjauan mengenai situasi malaria di Irian Jaya hingga tahun 1980.

Malaria merupakan masalah kesehatan masyarakat yang penting karena menyebabkan 14% dari kematian di rumah sakit dan 20% dari kunjungan ke fasilitas kesehatan.

Malaria adalah hiper sampai mesoendemik di daerah pantai dan dataran rendah, sedangkan di daerah pegunungan sampai ketinggian 1700 m malaria tidak stabil dan potensial epidemik.

Yang menjadi vektor ialah kelompok *Anopheles punctulatus* yang exo atau endophagik secara fakultatif serta bersifat exofilik.

Program pemberantasan malaria yang didasarkan pada penyemprotan rumah dengan DDT melindungi sekitar 300.000 penduduk di 15 lokasi.

Di semua lokasi penyemprotan angka parasit memang turun, kecuali di daerah Genyem (Nimboran) di mana dicurigai adanya resistensi nyamuk terhadap DDT, tetapi transmisi malaria masih berjalan terus. Pembagian obat secara massal (chloroquin dan pyrimethamin) juga tidak menghasilkan penurunan penularan yang diharapkan.

Pemberantasan malaria di Irian Jaya menghadapi berbagai hambatan yang sangat besar. Selain masalah operasional, keuangan dan perilaku manusia, terdapat pula masalah teknis seperti berkembangnya resistensi *P. falciparum* terhadap pyrimethamin dan proguanil (1959), chloroquin (1973) dan sulfadoxin/fansidar (1979) serta kemungkinan berkembangnya resistensi vektor terhadap DDT.

Pemberantasan malaria di Irian Jaya perlu dievaluasi secara menyeluruh dan penelitian yang bersifat operasional perlu dilaksanakan untuk menyusun suatu program yang lebih rasional dan sesuai dengan kondisi setempat.

Meningkatnya malaria akan menghambat pembangunan, maka penanggulangannya mutlak dilaksanakan untuk menjamin berhasilnya proyek-proyek pembangunan sosial-ekonomi di propinsi tersebut.

INTRODUCTION

Malaria is undoubtedly one of the most important public health problems in Irian Jaya. The severity of the disease, although not uniformly distributed all over the province, is considered an important obstacle for further socio-economic development.

This paper gives a brief account of the malaria situation and the antimalaria programme in Irian Jaya as of 1980 when the writer left the area after a service of more than 17 years in various parts of the province. In recent years more extensive operational investigations on malaria have been carried out, and a lot of effort has been made to control the disease in the province. In view of not much information available prior to 1980, the present review, hopefully may serve as a background reference on malaria in Irian Jaya.

*) This review is adapted from a report prepared by the writer for the Eight South-west Pacific Malaria Conference in 1980.

1. National Institute of Health Research & Development.

GENERAL INFORMATION

Irian Jaya, the most eastern province of Indonesia, consists of the western half of New Guinea and adjacent smaller islands. It has a land area of 422,000 square km and shares a border with Papua New Guinea of 750 km. A central mountain range with rock masses reaching altitudes above the snowline (above 5,000 m) divides the area roughly into a northern hilly part and southern lowland plains.

Irian Jaya is one of the most difficult travellable areas in Indonesia. Communication between the towns is done by plane or ship, while the smaller settlements and villages can only be reached by foot, canoe or small one-engined planes. Roads for motor transport are to be found only in and around the urban centres of Jayapura, Biak, Manokwari, Sorong and Merauke. The total length of roads does not exceed 2000 km and the longest stretch of paved road is 100 km from Jayapura to Genyem.

The climate is characterized by perennial rainfall and only in the Merauke region on the South coast a distinct dry season can be found between May and October.

According to a census in 1980 the population totalled 1,107,291. This is probably an underestimate as there are many population groups in the highlands which have not been brought under effective government administration. The population density is approx.2.7 per square km. About 20% of the population lives in urban areas, while the remaining 80% is scattered over more than 3000 *kampungs* or hamlets.

The extreme isolation and difficult communication have prevented any intensive contact with more developed civilizations and produced an enormous variety and diversity of cultures. More than 200 different languages have been identified in Irian Jaya.

The province has important natural resources like oil, copper, nickel, timber, copra, nutmeg, fish, prawns, etc. but most of the indigenous population still live in the sphere of half-monetized subsistance economy. (Manning & Garnaut, 1972).

The Gross Domestic Product of Irian Jaya in 1975 amounted to US $ 359,421, 150 which gives a per capita income of US $ 354. If we exclude the mining sector, the per capita income is US $ 215. (BAPPENAS, Biro Sensus, 1977).

Government administration is of fairly recent times. The first permanent government post was established in 1898 in Fak-Fak. Activities of the government and missions gradually extended from then on. Important explorations were made by the army and an oil company before the Second World War.

During World War II, the territory became important on account of its strategic position. Both the Japanese and Americans built roads, harbours, airfields, watersupply and other facilities for their armies and in this way provided the territory with some basic infrastructure.

When in 1949 the Netherlands acknowledged the independence of Indonesia, Irian Jaya remained under Dutch administration, pending a definite arrangement. The Dutch-Indonesian dispute came to a climax in 1962 and as a result of negotiations, the administration was transferred to Indonesia in May 1963 after a temporary administration by the United Nations. A provision was made for a "determination of people's opinion" to decide the future of the territory. This was held in 1969 and the greater part of the people's representatives has decided to remain within the Republic of Indonesia.

The Province is headed by a Governor

who is appointed by the President on the advice of the Provincial House of Representatives.

The Province is divided into 9 *Kabupatens* (regencies), 117 *Kecamatans* (districts) and 850 *Desas* (administrative villages).

The Provincial budget for 1979/1980 was Rp.24.8 billion or about US $ 40 million. In addition there was a development budget of Rp.15.5 billion or US $ 24.8 million provided by the Central Government.

The routine Provincial health budget in 1979/1980 was almost Rp.2 billion or US $ 3.2 million. The health development budget was Rp. 655.8 million or US $ 1.05 million. This gives a total Government health expenditure of US $ 4.25 million or about US $ 4.25 per capita in 1979.

The health services are headed by the Director who is answerable to the Governor. As Representative of the Central Department of Health, he is answerable to the Minister in Jakarta.

The Government health facilities in 1980 included : 1 provincial general hospital (300 beds), 1 mental hospital (75 beds), 8 regency general hospitals (543 beds), 19 rural hospitals (460 beds), 110 health centres, 106 policlinics/sub-health centres, 61 MCH centres.

Private/mission health facilities included : 6 hospitals (398 beds), 70 policlinics, 11 MCH centres and approx. 200 rural health posts.

The Government health services employed approx. 2500 people which included : 85 medical officers, 10 dental officers, 12 nursing/midwifery tutors, 246 nurses, 290 assistant nurses, 563 nurse aides, 85 midwives, 175 assistant midwives/midwifery aides, 4 pharmacists, 14 assistant pharmacists, 64 pharmacy aides, 6 laboratory technicians, 41 assistant laboratory technicians/laboratory aides, 12 health inspectors, 26 sanitarians, 20 assistant sanitarians, 37 microscopists, 116 spraymen. (Gunawan, 1976).

THE ORIGINAL MALARIA SITUATION

During the early 1800 swamp fever among the inhabitants was so widespread that the first military post, Fort du Bus, established in 1828 had to be closed eight years later because of it. The fever-stricken, bedridden garrison was unable to perform any duties (Bierdrager & de Rook, 1954). Malaria also took a heavy toll among the indigenous populations, especially the youngest age-groups. Metselaar (1957) found an infant mortality rate of 35% in Sentani before the start of DDT spraying. The original malaria endemicity was well documented in the Second Inter-territorial Malaria Conference for the Southwest Pacific by Van Dijk (1961).

Malaria endemicity is higher along the coast and offshore islands than that along the North coast, while farther inland in the lower hilly areas, transmission occurs ofr the greater part of the year. The transmission becomes less and less at increasing altitudes. At altitudes which range from 350 to 1500 metres transmission is often of a highly unstable, potentially epidemic type, similar to the malaria situation in the highlands of Papua New Guinea (Maffi et.al., 1975). Metselaar (1959) found transmission up to an altitude of 1600 metres and anophelism without malaria at an altitude of above 1600 metres.

There are many factors in the way of living of the people which favours transmission of malaria and interferes with the effectiveness of DDT house spraying: semi nomadism, cutting of forests, sleeping in garden houses, minimal clothing, absence of cattle, scarcity of mosquito nets, cultivation of *kangkung* (Ipomoea sp.) etc.

It is not certain whether genetic factors play a role in the development of immunity to malaria. Metselaar and Van Thiel (1959) were of the opinion that Irianese may possess an innate resistance to *P. falciparum*. Prins and Loos (1962) found deficiency of glucose-6-phosphate-dehydrogenase in only 0 — 3.0% of the highland population against 3.8 — 13.3% of the population in highly malarious areas in the lowlands. The sickle cell trait, however, does not seem to play a role. Metselaar (1957) did not find any sickle cells in 319 specimens which he examined in Jayapura.

MALARIA VECTORS

In Irian Jaya, malaria vectors belong to the member of the *Anopheles punctulatus* group, viz. *An. puctulatus*, *An. farauti*, *An. koliensis*, *An. bancrofti* which are the Australasian species, and the Oriental species, *An. subpictus* and *An. karwari*. The Australian species are widespread, and the Oriental species are very restricted in their distribution. The mosquitoes of the *An. punctulatus* group breed indiscriminately in all types of water collections. Their only demand being some sunshine. Such water collections are mostly man-made: ditches, footprints, wheel ruts, *kangkung* beds, canoes and empty drums or in pools produced by the digging and bathing activities of pigs.

Metselaar (1957) organised longitudinal studies over 81 "whole night" catches for 28 calendar weeks beginning January 1955, covering both rainy and non-rainy seasons. The results of his studies revealed that populations of *An. punctulatus* group have distinct seasonality. The peak of these population reaches during the rainy season (November to April) and the density tapers off to very insignificant levels during the dry season (May to October). He also established a direct correlation of prevalence of *An. punctulatus* population with rainfall.

The studies concluded that during the rainy season (rainfall above 220 mm) of five months, the average biting rate was 64 mosquitoes per night/per person and it dropped to 20 mosquitoes per night/person during the dry months. From his data it is apparent that population of *An. punctulatus* are highly unstable, as these are not only affected by low rainfall during non-rainy season, but also by "dry spells" during rainy season. Van Thiel & Metselaar (1955) in their experimental studies during rainy season and dry spell period showed similar biting rates as that found by Metselaar (1957). Their studies further confirmed that the *punctulatus* population even during the rainy season remain highly vulnerable to climate factors and do not form a stable population.

The behaviour of the *An. punctulatus* group of mosquitoes is classified as facultatively exo- or -endophagous and exophilous by Slooff (1964). Precipitation tests on the gut contents of female mosquitoes from various capture stations showed no host preferences, and can be easily lured away from man in areas where other mammalian hosts are in abundance (Metselaar, 1957; Van Den Assen & Van Dijk, 1959; Slooff, 1964). They concluded that *An. punctulatus* groups are indiscriminate feeders in nature.

THE DEVELOPMENT OF MALARIA CONTROL IN IRIAN JAYA

Before 1954 measures to control malaria consisted of oiling breeding places in some centres, incidental drainage works and chemoprophylaxis to the non-indigenous population (Black, 1955).

In 1953 experimental tests on hut-scale with 5% DDT (wdp) were started,

followed by a field trial with 5% DDT (wdp) at 2 gm/m^2 indoor-spraying in the Sentani area (Van Thiel & Metselaar, 1955). In addition to this DDT (wdp) mixed with dieldrin (0.125 mg dieldrin with 2 gm DDT/m^2) was carried out in the Nimboran and Merauke areas (Van Den Assen & Van Dijk, 1959). On the basis of promising results in the Sentani area, 5% DDT at 2 gm/m^2 at six months interval became the routine procedure. The DDT house spraying campaign was gradually extended and by the end of 1961 approximately 250,000 people were covered by the campaign.

Mass drug distribution with chloroquine and pyrimethamine twice a year have been introduced since 1958 as in most areas, despite the sharp reduction in parasite rates, transmission was not interrupted. The results of the combination of DDT spraying and mass drug distribution varied : in some areas interruption of transmission was almost achieved, elsewhere it was without lasting effect (Van Dijk, 1958). Drug distribution appeared to be of great help in bringing down parasite rates more rapidly in areas where these rates already showed a tendency to diminish because of the DDT house spraying, (Metselaar, 1961).

To control malaria in problem areas (where DDT house spraying gave disappointing results), Pinotti's method of distributing medicated salt have been tried in Arso, Waris, Tor and Sarmi East Coast. Pyrimethamine and later chloroquine was mixed with table salt and distributed to the population in 1959—1961. Resistance of *P. falciparum* to pyrimethamine developed a few months after the start of the project and the distribution of chloroquinized salt, even when combined with DDT house spraying, gave disappointing results (Meuwissen, 1963).

A malaria pre-eradication programme, to be assisted by WHO and UNICEF, was prepared in 1961. This could not be implemented as the Netherlands had to transfer the administration of the area to the United Nations in 1962 and the latter to Indonesia in 1963.

The malaria eradication programme in Indonesia at that time was limited to Java and Bali and no funds were available to extend it to the other islands. However, a branch of the National Malaria Eradication Command was established in Irian Jaya to maintain the malaria control programme initiated by the Netherlands administration.

Hyperinflation, political upheavel and the cessation of USAID assistance led to a setback of the malaria eradication programme in Java and Bali and prevented the expansion of the programme to the other islands.

The breakdown in communications, the diminished central government subsidies and the shortage of competent personnel lead to a deterioration of services in Irian Jaya, including malaria control. Conditions started to improve after 1968 when the political situation was stabilized, the hyper-inflation controlled and a realistic development plan was prepared.

The Malaria Eradication Command in Irian Jaya (KOPEMDA) was disbanded and malaria control was decentralized and integrated into the general health services.

The malaria control programme was reactivated in 1970 with the assistance of FUNDWI (Fund of the United Nations for the Development of West Irian). DDT house spraying was carried out in areas of socio-economic importance. With some assistance from USAID it was possible to extend the programme in 1975 to 15 locations. Spraying operations in 1980 protected about 300,000 people or about 40% of the population living in highly malarious areas.

THE MALARIA CONTROL PROGRAMME

The objectives of the malaria control programme in Irian Jaya in 1980 were :

(1) to reduce endemicity to levels not hampering socio-economic development, i.e. achieve an overall parasite rate in sprayed areas of less than 2%;

(2) to reduce mortality and morbidity due to malaria to negligible levels.

The malaria control activities consist of :

(1) DDT residual house spraying twice a year to protect 300,000 people in 15 locations of socio-economic importance;

(2) Larviciding with malariol of limited breeding places in 4 urban areas;

(3) Parasite surveys twice a year in sprayed areas;

(4) Entomological surveys/susceptibility tests of local vectors to DDT;

(5) Investigations to detect the distribution of chloroquine resistance;

(6) Purchase, production and distribution of drugs for the treatment of malaria in all health facillities;

(7) Health education with special emphasis on the acceptance of DDT house spraying and prevention of malaria;

(8) Training and upgrading of existing health personnel in malaria control;

(9) Supervision of local malaria control activities by the provincial staff.

The full time staff engaged in malaria control can be seen in Table 1.

A medical officer was in charge of malaria control at provincial HQ, but he had also other duties as chief of the CDC division. There was no professional entomologist, most of the routine entomological work was being done by sanitarians who have been given additional training in Java and Irian Jaya.

The local medical officers were expected to supervise malaria control activities, but only a few of them have been given additional training in malaria control. The sanitarians and assistant sanitarians engaged in malaria control have all been given in-service training in Jayapura.

The funds available for malaria control operations in 1980/1981 (excluding salaries) was Rp.93,396,000. The breakdown of the budget is shown in Table 2.

The salaries of staff engaged in malaria control (full time) was approximately Rp. 85 million per year. Combined with the above operational budget the costs of malaria control in 1980 amount to approximately Rp. 178,396,000 or US $ 285,000. This is about US $ 1,25 per person protected.

THE TREND IN OPERATIONAL AREAS

The total number of houses sprayed in 1979 (cycle I) was 32,609. A total of 2,589 houses were unsprayed, giving a refusal rate of 7,2%.

DDT (wdp) residual house spraying was still acceptable in most areas in 1980. Only in the more urbanized centres of Jayapura, Biak and Sorong was the percentage of refusal more than 10%. The most frequent reasons for refusal have been the mess caused by DDT wettable powder and the opinion that spraying did not decrease malaria and the number of mosquitoes.

Parasite rates have declined where spraying operations are carried out, except in Genyem (Nimboran district) about a 100 km from Jayapura (Table 3). The decline in the adjacent areas : Sentani,

Table 1. Staff engaged in malaria control in Irian Jaya (1980).

	Location	Health inspector/ Sanitarian	Assistant sanitarian	Microscopist	Sprayman
1.	Provincial HQ	3	3	1	—
2.	Jayapura	1	1	1	14
3.	Abepura	—	1	1	12
4.	Sentani	—	2	1	6
5.	Genyem/Nimboran	—	1	1	6
6.	Sarmi	—	—	2	4
7.	Biak	1	—	9	12
8.	Serui	1	4	3	5
9.	Nabire	1	—	4	5
10.	Manokwari	1	3	3	12
11.	Oransbari	—	1	—	2
12.	Sorong	1	1	2	15
13.	Teminabuan	—	1	3	2
14.	Fak Fak	1	1	1	8
15.	Kaimana	—	1	3	3
16.	Merauke	—	—	2	10
	Total	10	20	37	116

Table 2. Operational budget for malaria control, Irian Jaya 1980/1981.

1.	DDT—WP (30 tons)	Rp.	48,910,000
2.	Spraying/larviciding operations	Rp.	27,505,000
3.	Parasite surveys/entomological surveys	Rp.	6,931,000
4.	Malaria drugs	Rp.	5,250,000
5.	Supervision	Rp.	3,000,000
6.	Training	Rp.	1,800,000
	Total	Rp.	93,396,000

Abepura and Jayapura was also not very convincing. Substandard operations played a role, but the possibility of DDT resistance was also being considered. Change in mosquito behaviour is another possibility.

An interesting finding from the annual parasite surveys is the persistance or even increase of the percentage of *P. falciparum* infections (Table 4).

Transmission was still going on in most sprayed areas as can be seen from the infant parasite rates which were still considerable except in Biak and Merauke (Table 5).

Slide positivity rates have remained high, ranging from 14.1% in Merauke and 51.1% in Nabire. Most of these slides have been taken from fever cases treated in

Table 3. Results of parasite surveys in Irian Jaya, 1970 — 1979.

No.	Location	Parasite Rate				
		1970/71	1975/76	1977	1978	1979
1.	Jayapura	10.1	10.4	10.3	5.3	6.0
2.	Abepura	20.6	27.3	25.7	18.65	18.3
3.	Sentani	23.2	22.0	18.1	11.6	15.4
4.	Genyem	—	19.2	23.4	35.0	23.0
5.	Sarmi	—	28.5	9.5	10.67	9.6
6.	Biak	7.1	2.1	2.3	1.5	1.4
7.	Serui	—	25.5	10.6	15.8	17.7
8.	Nabire	—	19.7	11.6	9.8	—
9.	Manokwari	37.2	8.8	4.4	6.5	10.4
10.	Oransbari	—	6.4	7.8	18.0	5.2
11.	Sorong	28.9	15.3	11.4	4.9	4.8
12.	Teminabuan	—	10.4	10.6	4.3	6.0
13.	Fak Fak	25.7	17.3	7.7	3.6	2.5
14.	Kaimana	—	3.9	6.9	5.4	—
15.	Merauke	0.36	1.3	0.8	1.3	0.6

Table 4. Percentage of *P. falciparum* (results of parasite surveys in Irian Jaya, during 1970 — 1979)

	Location	Percetage of *P. falciparum*				
		1970/71	1975	1977	1978	1979
1.	Jayapura	50.3	31.8	55.1	73.3	66.6
2.	Abepura	48.6	48.7	59.3	50.5	64.8
3.	Sentani	51.5	76.9	41.2	62.6	65.4
4.	Genyem	—	62.5	74.4	78.2	73.8
5.	Sarmi	—	69.6	75.7	57.1	78.1
6.	Biak	78.5	32.7	30.9	27.5	26.6
7.	Serui	—	87.6	86.4	87.7	73.3
8.	Nabire	—	46.5	45.4	47.7	—
9.	Manokwari	80.4	42.4	40.8	48.7	40.0
10.	Oransbari	—	30.3	41.0	36.3	12.0
11.	Sorong	44.6	42.0	46.7	30.0	29.1
12.	Teminabuan	—	62.5	15.4	22.9	50.0
13.	Fak Fak	57.0	54.2	53.2	38.1	36.2
14.	Kaimana	—	84.7	64.5	93.6	—
15.	Merauke	16.6	3.5	0	0	14.2

hospitals, health centres and policlinics.

Hospital records indicated that malaria was responsible for 16% of all admissions and 14% of all hospital deaths in 1975 — 1979.

Gunawan and Subianto (1975) analysed the malaria cases admitted to Jayapura hospital in 1972 and found a case fatality rate of 3.5%. Of 21 malaria deaths, 15 were caused by cerebral malaria and 6 were caused by renal failure, severe anemia and heart failure. The number of malaria cases reported by

Table 5. Infant Parasite Rate
(results of parasite surveys in Irian Jaya, 1970 – 1979)

	Location	Infant Parasite Rate					
		1970/71	1975	1976	1977	1978	1979
1.	Jayapura	4.1	6.9	6.7	7.7	2.6	4.2
2.	Abepura	10.8	12.9	18.8	25.7	5.7	13.1
3.	Sentani	21.6	33.0	18.5	16.8	16.8	12.5
4.	Genyem	—	13.3	2.3	15.3	21.9	29.6
5.	Sarmi	—	28.9	12.9	13.2	14.2	19.8
6.	Biak	7.3	1.3	1.0	1.6	1.0	0
7.	Serui	—	22.5	6.4	8.7	13.0	10.4
8.	Nabire	—	37.5	13.6	19.1	19.0	—
9.	Manokwari	27.2	3.4	4.8	4.3	2.6	8.6
10.	Oransbari	—	0	5.4	0	9.6	4.0
11.	Sorong	35.2	10.8	15.8	8.8	5.1	7.1
12.	Teminabuan	—	38.0	9.0	2.4	2.6	2.7
13.	Fak Fak	12.5	4.5	6.8	2.9	7.2	5.7
14.	Kaimana	—	—	—	6.0	3.0	—
15.	Merauke	1.1	0	0	0	0	1.6

outpatient departments of hospitals, health centres and policlinics in 1979 totalled 83,171 and this was 20% of all reported consultations.

CONSTRAINTS TO MALARIA CONTROL

The malaria control programme in Irian Jaya has been able to reduce the parasite rates in the areas under protection and thus made a considerable contribution to the general improvement of health and the socio-economic development of the area. But due to many constraints, the original objectives of the programme have not yet been achieved.

The constraints to malaria control in Irian Jaya include :

(1) The lack of understanding of the importance of malaria to health and socio-economic development;

(2) The lack of coordination of malaria control activities and development projects especially transmigration and resettlement projects;

(3) Difficulties in attracting and retaining experienced qualified personnel;

(4) Inadequate funds, transport and materials & equipment;

(5) Poor supervision resulting in operational standards of a level below that required to effectively control malaria;

(6) Resistance to spraying in some areas;

(7) Population movements/urbanization/ spontaneous transmigration from elsewhere in Indonesia;

(8) Behaviour of people favouring transmission;

(9) Behaviour of mosquitoes leading to avoidance of contract with sprayed insecticides;

(10) Development of drug resistance by malaria parasites;

(11) Development of DDT resistance by local vectors (need confirmation);

(12) The lack of an appropriate strategy and commitment to control malaria.

THE PROBLEM OF DRUG RESISTANCE

Meuwissen (1961) reported that in 1959 in the Arso district (30 km south of Jayapura), three months after the initiation of a project to control malaria by the distribution of pyrimethaminized salt, *P. falciparum* developed resistance to pyrimethamine. He also could establish the presence of cross-resistance to proquanil.

The project later switched to chloroquinized salt. Owning to disappointing results this project was discontinued in 1961. It was not clear whether chloroquine resistance played a role.

Meuwissen (1963) already noted that the response of *P. falciparum* in Jayapura was slower than elsewhere. He found that 12 of the 29 subjects examined became negative only after 144 hours after the administration of a standard dose of chloroquine. Whether recrudescence occurred within 21 days was not investigated.

Chloroquine resistance was suspected in Jayapura because there was intense transmission (in spite of DDT house spraying) combined with the movement of non-immune people from non-endemic areas and a history of intense drug pressure (medicated salt project and mass drug distribution).

Verdrager et al (1976) carried out the WHO standard field test for assessing the response of *P. falciparum* to a standard dose of chloroquine in 35 subjects from Jayapura. There was no evidence of resistance at the R.II or R.III level. There was one patient with early recrudescence, while among 27 other subjects followed up until day 21, 6 were found again with asexual parasites. Reinfection cannot be completely excluded, but most of the cases found positive again within 21 days were probably late recrudescences.

Two imported chloroquine resistant *falciparum* infections (R.I) were detected in Japan in 1975 among Japanese who had worked in Manokwari and Nabire (Ebisawa & Fukuyama 1975). Another imported resistant *falciparum* infection was detected in England by Manson Bahr, an English biologist, who had visited various parts of Irian Jaya. The strain was sent to Clyde in USA and subinoculated into volunteers for drug characterization. It was found that this strain was resistant at the R.II level to chloroquine 1.5 g over 3 days, at the R.III level to pyrimethamine 150 mg over 3 days, at the R.I level to quinine 2 g daily for 14 days and breaks through prophylaxis with 100 mg proquanil daily (Clyde et al. 1976).

A case of Fansidar resistant *falciparum* malaria at the R.I level has been documented by Rumans et al (1979). The patient was an Indonesian entomologist participating in a field survey in the Freeport copper mining area on the south coast of Irian Jaya. He got *falciparum* malaria inspite of regular prophylaxis with 300 mg chloroquine twice a week. He received two courses of treatment with Fansidar (75 mg pyrimethamine and 1500 mg sulfadoxine twice), but has relapsed on both occasions requiring therapy with a combination of quinine and sulfadiazine.

Dimpudus and Laksamana (1980) did an investigation to detect chloroquine resistance by the in vivo and in vitro test in the Nimboran district about 100 km from Jayapura. They found an overall parasite rate of 15.8%, 70% of which were *P. falciparum* infections. The spleen rate among school children was 72% (age 5 — 9 years), 78% (10 — 14 years) and 50% (15 years and older), while the average enlarged spleen was 2.8, 2.8 and 2.7 respectively. In vivo and in vitro tests to detect *P. falciparum* resistance to 4-aminoquinolines according to WHO

Table 6. Results of susceptibility tests of *Anopheles* mosquitoes to DDT (using DDT impregnated papers of 4.0%)

Year	Location	Species	Mortality
1971	Jayapura	*A. farauti*	100%
	Sorong	,,	100%
	Biak	,,	100%
	Merauke	,,	92.5%
1972	Jayapura	*A. koliensis*	100%
	Sorong	*A. farauti*	95.7%
	Biak	,,	100%
	Merauke	,,	100%
	Manokwari	,,	100%
1973	Jayapura	*A. koliensis*	100%
1974	Jayapura	*A. koliensis*	100%
	Sorong	*A. farauti*	100%
1975	Jayapura	*A. koliensis*	97%
		A. farauti	100%
1976	Sorong	*A. punctulatus*	100%
	Jayapura	*A. farauti*	86.6%
1977	Jayapura	*A. koliensis*	79.5%
	Sorong	*A. farauti*	100%
	Biak	,,	100%
	Merauke	*A. bancrofti*	61.5%
		A. farauti	98.1%
	Manokwari	,,	100%
	Nabire	,,	100%
1978	Jayapura	*A. farauti*	73.0%
1979	Sorong	*A. farauti*	93.3%
1980	Nimboran/Jayapura	*A. koliensis*	25.0%

standard procedures were carried out with 21 subjects. They found 6 cases of chloroquine resistance in vitro, 2 of which were also resistant in vivo at the R.II level.

The above data suggest a widely scattered distribution in Irian Jaya of chloroquine resistant *falciparum* malaria, possibly associated with crossresistance to pyrimethamine, proguanil and sulfadoxin. This is obviously a serious problem which will complicate malaria control.

THE PROBLEM OF DDT RESISTANCE

Bio-assay and susceptibility tests to DDT were carried out annually since 1971 and no resistance of the malaria vectors could be demonstrated until recently when indications of DDT resistance of *A. koliensis* were found in the Nimboran district (Table 6).

The finding of only 25% mortality of *A. koliensis* in the Nimboran district near Jayapura was obviously a serious matter which needed confirmation (Finthay, 1980). The results of parasite surveys supported the presence of DDT resistance as there was no decrease after 4 years of DDT house spraying. Further investigations are needed to know the distribution of DDT resistance in Irian Jaya, as this may have important consequences for the

control of malaria in the area.

SUMMARY AND CONCLUSIONS

This paper is a review on the malaria situation in Irian Jaya prior to 1980. A general description has been given on the geography, demography, socio-economic development and general health infrastructure of the province.

Malaria is an important public health problem responsible for 16% of all hospital admissions, 14% of all hospital deaths and 20% of all outpatient consultations in Irian Jaya. It is hyper- to mesoendemic in the coastal and lowland areas, while it is unstable and potentially epidemic in the highlands up to an altitude of 1700 metres.

The vectors belong to the Anopheles punctulatus group which are facultatively exo- or -endophagous and exophilous.

The malaria control programme, based on DDT (WP) residual house spraying, protected approx. 300,00 people in 15 locations of socio-economic importance or 40% of the population in highly malarious areas in 1980. Parasite rates have declined in all areas where spraying operations have been carried out, except in Genyem (Nimboran) where DDT resistance is suspected. But transmission was still going on at a considerable intensity except in Biak and Merauke where the overall parasite rate is less than 2% and the infant parasite rate 0%. In the other areas where malaria is hyperendemic, only a moderate reduction can be achieved. Mass drug and medicated salt distribution gave disappointing results.

The malaria control programme in Irian Jaya has to operate within formidable constraints. Besides operational, financial and human behavioural problems there are technical problems like the emergence of resistance of *P. falciparum* to pyrimethamine and proguanil (1959), chloroquine (1973) and sulfadoxin (1979). DDT resistance of *A. koliensis* in the Nimboran district is suspected and needs further investigations. A thorough assessment of the present malaria control activities and appropriate research are urgently needed in order to conduct a rational and feasible control programme. A further increase of malaria would seriously impede development in Irian Jaya. Malaria control, at least in and around development centres is essential to the economic and social development of the province.

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