THE PROJECT FOR THE PROMOTION OF HEALTH IN NORTH SUMATRA

WITH SPECIAL ATTENTION TO THE ASAHAN AREA

(THE INTERNATIONAL COOPERATION PROGRAM
BETWEEN
THE REPUBLIC OF INDONESIA AND JAPAN)

JULY 1982

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

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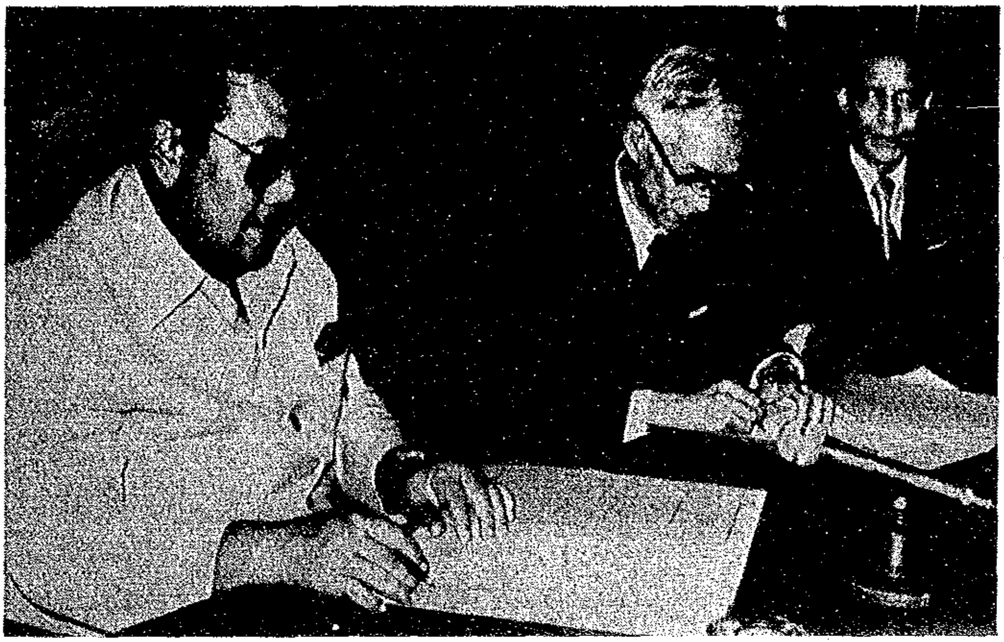

Placing their signatures on the record of discussion. (from left)

Dr. Djaka Sutadiwiria	Secretary General, Ministry of Health, The Republic of Indonesia
Dr. Tadashi Takeuchi	Head of Japanese Implementation Survey Team
Mr. Sakae Tsurumi	Director of the JICA Jakarta Overseas Office

FOREWORD

Japan International Cooperation Agency (JICA), in cooperation with the Government of the Republic of Indonesia, has been extending medical cooperation to "The Project for the Promotion of Health in North Sumatra with Special Attention to the Asahan Area" since 1978. This Project has been implemented as a comprehansive health program for the health promotion of people in north Sumatra where, particularly in the Asahan area, a rapid industrial development is remarkablly progressing in recent years. The Project is mainly aimed at strengthening public health laboratory systems, improving medical services, promoting communicable disease and parasitic disease control activities, and etc.

JICA requested Japanese Organisation for International Cooperation in Family Planning, Inc. (JOICFP) to compile a report for the Project's overall evaluation and future planning, as the five-year cooperation period terminates at the end of March 1983. I firmly believe that the report is very meaningful for the Project and would like to thank all people engaged in its preparation.

July 1982

Masao Hasegawa
Executive Director
Japan International Cooperation Agency

FOREWARD

This is a report to review the Project (OTA-43) for the promotion of health in North Sumatra with special attention to the Asahan area which has been operating based on the Record of Discussion on 13th Octover 1977. This report is requested by Japan International Co-operation Agency to prepare for evaluation program, which will be held later this summer of 1982.

As the background of OTA-43, it is stated in the R/D that:

> Recognising that the promotion of health is one of the most important task to support economic development in Indonesia, which will greatly contribute to the advancement the welfare of the people and to social development of the country.

OTA-43 has been operating as Five Year Program from 1st April 1978 to 31st March 1983 for the promotion of community health in surrounding area of Asahan Development Project (at Smelter Site). JICA has contracted with Japanese Organization For International Co-operation in Family Planning, INC. (JOICFP) to produce the report through experts concerned the Project (OTA-43). JICA has also provided all necessary documents and reports related to OTA-43 for JOICFP to review the project.

All activities mentioned in this report have been carried out for the performance of OTA-43 along the policy of Indonesian Government to achieve the purpose of the promotion of health in North Sumatra with special attention to Asahan area by Japanese experts and counter-parts of Indonesia. The report is written by each individual Japanese experts concerned. He is liable for his writings. His name is attached to the end of his report.

However, it is not aimed at his own authorship as research paper in principle. The project of the promotion of health in certain area requires many years with wide scope and complex process. It is the new theme for the project of international technical co-operation. It is requested by JICA to point out necessary problem issues along the process of project planning and implementation in reality. Therefore, it is tried to present the objective and honest report as possible in addition to scientific, technical, and administrative report.

All members of editors and writers of this report wish to acknowledge at first, extraordinary leadership of Dr. R. Soebekti M.P.H. Chairman of the Steering Committee of OTA-43 project as

Director-General of Community Health, Ministry of Health, and Dr. H. Djafar, Project Manager as Director of Health Service of North Sumatra Provincial Government, and secondly, Dr. Soeharto as Secretary and Dr. S. Karo-Karo as Liason Officer of the Project in Jakarta, Dr. Tampubolon as Deputy Manager of the Project in Medan, and thirdly, all other Indonesian officials and persons concerned in the Project Area, Kisaran, Medan and Jakarta.

All member of reporters would like to express our thanks to Mr. Y. Yoshida, Mr. Y. Satsumabayashi, Mr. Y. Nagai and Mr. Y. Shiroishi for their efforts to produce this report in short time. Because of the budget flame work, we can not help cutting and summarizing certain papers of experts. Prof. A. Ishi, Dr. M. Yasuno and M. Hashimoto served final editorial role.

We hope this report will make profitable contribution for further development of the Project and also similar project in future.

30th July 1982

M. Hashimoto
Chairman, Domestic Committee
for OTA-43, JICA

List of Indonesian Officials and Counterparts

Ministory of Health

Dr. R. Soebekti MD, MPH		Director General, Directorate of Community Health Chairman, Steering Committee	
Dr. M. Adhyatma	MD	Director General, Directorate of Communicable Disease Control	
Dr. D.D. Prawiranegara		Director General, Directorate of Medical Care	
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Mr. W. Widodo	DPH	Director, Directorate of Hygiene and Sanitation	RWS
Mr. Soemali		Head, Water Supply Division	RWS
Mr. D. Luthfi		Staff, Directorate of Hygiene and Sanitation	RWS
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Mr. M. Ginting		Chief, Food and Drinks Microbiology Section, Health Laboratory in Medan	LAB
Dr. Y. Hadiah		Chief, Section of Serology, Medan Health Laboratory	LAB
Dr. R.P. Purba	MD	Former Chief, Subsection of Parasitology, Health Laboratory in Medan	LAB
Mr. K. Brahmana		Chief, Subsection of Parasitology, Medan Health Laboratory	LAB
Miss Y. Purba		Staff, Subsection of Parasitology, Medan Health Laboratory	LAB
Mr. M.N. Puteh		Malaria Control, Directorate of Communicable Disease Control, MOH	MAL

North Sumatra Provincial Health Service

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Dr. R. Tampubolon	MPH	Deputy Manager, Asahan Health Project, Medan	AHG
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Asahan Regency Health Service

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Dr. A. Sjukri	Chief, Lima Puluh Health Center, Asahan	AHG
Dr. R.E. Lubis	Chief, Pagrawan Health Center, Asahan	AHG
Mr. H. Sutikuo B.Sc.	Staff, Asahan Health Services	RWS
Mr. W. Pohan	Staff, Vector Borne Diseases Subdirectorate, Communicable Disease Control Directorate, Provincial Health Service of North Sumatra, Medan	MAL
Dr. Sumitro		MAL
Mr. H. Hasipuan	Staff, Vector Borne Diseases Subdirectorate, Communicable Disease Control Directorate, Provincial Health Service of North Sumatra, Medan	MAL

AHG: Asahan Health in General
LAB: Laboratory
CDC: Communicable Disease Control
HE: Health Education
RWS: Rural Water Supply
MAL: Malaria Control
TB: Tuberculosis Control

CONTENTS

1 . Malaria Control

I. INTRODUCTION

(1) Background

In Indonesia, malaria control program has been restricted to Java and Bali for a long period, while the control operation using indoor spraying with DDT in North Sumatra was launched only at several spotted areas in 1970s.

In view of the risk of epidemics of malaria among increasing population, who have no immunity to malaria, due to the construction of the smelter site in the Asahan district in North Sumatra, the Ministry of Health decided the Asahan district is to be the high priority area, since then anti-malaria activities with residual spraying with DDT were initiated in this area in 1977. DDT was sprayed three times in 6 villages at an interval of 6 months from 1977 to 1978 and other villages from 1978 afterwards. In these 6 villages, malaria cases decreased as expected with the three round sprayings. It was believed from this result that the conventional approach using DDT was effective against malaria in this area. It was already suspected that the vector of malaria was Anopheles sundaicus and the team of the Department of Health has collected an information on the seasonal prevalence of this species at one village. Although relatively a large number of staff are engaging in this anti-malaria activity, they are lacking entomologyst. As far as the malaria cases, the blood examination by trained microscopysts at the department was limitted and therefore the most statistics were depended on the reports from Local Health Centers. Under the circumstances, it was not expected for the team of the department to provide biological information on vectors relevant to the control programme.

As stated in the report of the 16th WHO Expert Committee on Malaria, knowledge of the epidemiological and entomological factors under the local climatic and geographical conditions is essential to establish an effective control plan. Namely, if the ecology and behaviour of the vector as well as host (human) vary in relation to the environment, the control method must be changed to fit the local conditions.

Previous studies on Anopheles sundaicus

After the 1920s' survey on mosquito fauna by Dutch people at the colonial age (Swellengrebel and Rodenvaldt, 1932), practically no study has been carried out in Sumatra till Lien et al. (1975). Anopheles sundaicus was found an efficient vector by the early survey. Ecological study on this species in other islands was also limitted (Sundararaman et al. 1957, Ronnefeldt 1959, Reid 1961 and Russel et al. 1963), although it had been recognized as a major vector at the coastal regions of South India, Malasia and Indonesia. Recent study by Collins et al. (1979) in South Sulawesi was valuable to compare the ecology and behaviour of this species in North Sumatra.

(2) Objectives

Since there had been limitted knowledge on malaria epidemiology and entomology in the Asahan district, the objective to accomplish first was to obtain the actual figures on the prevalence of malaria in the area. Therefore a general survey was planned at the first step, including the studies on taxonomy and distribution of various mosquitos which would provide the basis for the future studies. For this purpose, surveys were carried out at six selected villages and it was found malaria was restricted to the coastal area. The second step was to carry out the malariological surveys as recommended by the WHO expert committee. For example, man-biting density per man per night, indoor resting mosquito density, proportion of parous mosquitos and parasitological study. These are useful for the computation of the risk of the transmission of malaria or for the assessment of the effect of DDT spraying.

The third step in this project was to assess the various control measures in that environment. In due course of the second step, a village with a high endemicity of malaria was selected for the basic study. This was Perupuk village and gave a chance to assess the indoor residual DDT spraying. Since this study required one year pre-treatment period and another one year post-treatment period, the most efforts of all the Japanese experts related to malaria program were devoted to this study. As stated in the later chapters, the team obtained an interesting and valuable data from this study, which will provide an important suggestion in the operation not only in North Sumatra but also in other islands of Indonesia.

(Masayuki Yasuno: 1978, Feb. 25~1978. Mar. 18, 1979. Feb. 23~1979. Mar. 15, 1980. Nov. 3~1980. Nov. 22)

II. MOSQUITO SURVEY IN THE ASAHAN HEALTH PROJECT AREA

(1) Mosquito Fauna

It is indispensable for community health to obtain all information on potential vectors of human diseases occurring the area. In this respect, surveys on mosquito or other vector insect fauna are the thing that should be done first of all the work of medical entomology. The surveys of this purpose, thus initiated in July 1979 and ended during the first half of April 1980.

In the field, adult mosquitos were collected from man and livestock at night, and by net-sweeping in the daytime. All kind of larval habitats were checked.

Almost all succeeding laboratory work had been done by the expert himself. Collected adult mosquitos were identified, and about 2,000 of them were mounted on minuten pins or on triangular paper points. Collected larvae were reared in the laboratory up to the adult stage individually or in mass. All the reared adults were mounted and identified. Larval and pupal exuvia of individually reared ones were preserved in alcohol vials in association with the emerged adults. Total number of species discovered is 59 (Table 1). Lien et al. (1975) reported the occurrence of 58 species from whole North Sumatra Province. Fifty nine species from much narrower area, 3 Kecamatan of Asahan Regency, may well represent the mosquito fauna of the Project Area.

Among them, 17 species (indicated by o) are not reported by Lien et al. (l.c.) from North Sumatra, 4 species (indicated by *) are new to Sumatra, and additional 3 species (indicated by **) are new to Indonesia.

To see the difference in fauna and abundance among villages surveyed, the obtained number of larvae (emerged adults) and females of blood-sucking species of warm-blooded animals are demonstrated in Table 2.

Table 1 List of the Mosquito Species Occurring in the Project Area

o1	Anopheles (Anopheles) argyropus (Swellengrebel, 1914)
o*2	" " lesteri Baisas & Hu, 1936
3	" " nigerrimus Giles, 1900
4	" " peditaeniatus (Leicester, 1908)
5	" " sinesis Wiedemann, 1828
6	" " baezai Gater, 1933
7	" (Cellia) annularis Van der Wulp, 1884
8	" " kochi Doenitz, 1901
9	" " sundaicus (Rodenwaldt, 1925)
10	" " tessellatus (Theobald, 1901)
11	" " vagus Doenitz, 1902
o**12	Ficalbia jacksoni Mattingly, 1949
o*13	" minima (Theobald, 1901)
o*14	Mimomyia (Mimomyia) aurea (Leicester, 1908)
15	" " chamberlaini Ludlow, 1904
o	" " " metallica (Leicester, 1908)
16	" (Etorleptiomyia) luzonensis (Ludlow, 1905)
o17	Mansonia (Coquillettidia) aureosquammata (Ludlow, 1909)
o18	" " crassipes (Van der Wulp, 1881)
19	" " nigrosignata (Edwards, 1917)
o20	" " ochracea (Theobald, 1903)
o21	" (Mansonioides) annulata Leicester, 1908
22	" " annulifera (Theobald, 1901)
23	" " bonneae Edwards, 1930
24	" " indiana Edwards, 1930
25	" " uniformis (Theobald, 1901)
26	Culex (Culex) pipiens quinquefasciatus Say, 1823
27	" " fuscocephala Theobald, 1907
28	" " gelidus Theobald, 1901
29	" " sitiens Wiedemann, 1828
o**30	" " barraudi Edwards, 1922
31	" " pseudovishnui Colless, 1957
32	" " tritaeniorhynchus Giles, 1901
33	" " bitaeniorhynchus Giles, 1901
34	" " sp. (bitaeniorhynchus-group)
35	" (Lopheceraomyia) variatus (Leicester, 1908)
36	" " sp. A
37	" " sp. B
38	" " sp. C
39	" (Culiciomyia) spathifurca (Edwards, 1915)
o40	" (Lutzia) fuscanus Wiedemann, 1820
o41	" " halifaxii Theobald, 1903
42	Aedes (Stegomyia) aegypti Linnaeus, 1762
43	" " albopictus (Skuse, 1895)
44	" " sp.
o**45	" (Aedimorphus) culicinus Edwards, 1922
46	" " vexans nocturnus Theobald, 1903
47	" " sp.
48	" (Neomelaniconion) lineatopennis (Ludlow, 1905)
49	" (Lorrainea) sp.
50	Armigeres (Armigeres) sp.
51	Uranotaenia (Pseudoficalbia) sp. A
52	" " sp. B
53	" (Uranotaenia) lateralis Ludlow, 1905
54	" " sp. B
55	" " sp. C
o*56	" " micans Leicester, 1908
57	" " sp. E
o58	Toxorhynchites (Toxorhynchites) sp. A
o59	" " sp. B

* New to Sumatra

** New to Indonesia

o Not in Lien et al., 1975

Table 2 Mosquito Collection from 9 Villages of the Asahan Project Area
(Ficalbia, Mimomyia, Uranotaenia & Toxorhynchites Excluded)

No.	Species	Perupuk-Guntung Jul 9-10 1979 Mar 4-5 1980		Limau Sundai Jul 23-24 1979 Mar 19 1980		Tanjung Muda Sep 10-11 1979 Mar 18 1980		Kuala Tanjung Jul 24 1979 Dec '79-Feb '80		Tanjung Gading Dec '79-Feb '80		Medan Sep 24-25 1979 Nov 27-28 1979 Apr 3 1980		Sei Buahkeras Oct 8-9 1979 Apr 2 1980		Pangkalan Dodek Apr 2 1980		Species No.
		Larva	Female	Larva	Female	Larva	Female	Larva	Female	Larva	Female	Larva	Female	Larva	Female	Larva	Female	
1	An (Ano) argytopus	-	-	-	-	-	1	-	-	-	-	1	13	-	1	-	-	1
2	" " lesteri	-	-	-	-	-	-	-	-	-	-	3	31	-	29	-	-	2
3	" " nigerrimus			-	-	-	-	-	4	-	3	-	-	-	-	-	-	3
4	" " peditaeniatus		-	1	-	4	5	-	3	-	9	1	3	-	-	-	-	4
5	" " sinensis	-	-	6	10	6	40	-	43	-	27	-	13	6	1	-	8	5
6	" (Cel) annularis	-	-	-	-	-	5*	-	-	-	-	-	-	-	-	-	-	6
7	" " kochi	-	-	-	-	3	5	-	-	-	-	-	-	-	-	-	-	7
8	" " sundaicus	135	249	-	-	-	-	-	8	-	5	-	86	-	33	-	44	8
9	" " tessellatus	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	9
10	" " vagus	-	2	83	73	10	29	-	-	-	-	-	-	-	-	-	-	10
11	Ma (Coq) aureosquammata	-	-	-	-	-	-	-	71	-	40	-	-	-	-	-	1	11
12	" " nigrosignata	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	12
13	" " ochracea	-	-	-	-	-	(1)	-	-	-	-	-	-	-	-	-	-	13
14	" (Mnd) annulata	-	-	-	1	-	53	-	5	-	17	-	5	-	-	-	-	14
15	" " annulifera	-	4	-	-	-	-	-	10	-	11	-	5	-	-	-	-	15
16	" " bonneae	-	-	-	-	-	4	-	8	-	46	-	3	-	-	-	-	16
17	" " indiana	-	24	-	5	-	94	-	40	-	42	-	20	-	6	-	2	17
18	" " uniformis	-	13	-	10	-	71	-	177	-	303	-	210	-	146	-	16	18
19	Cx (Cux) p. quinquefasciatus	-	-	-	-	17	1	-	2	-	1	-	-	2	-	-	8	19
20	" " fuscocephala	-	-	24	86	25	149	-	-	-	3	-	1	-	-	-	-	20
21	" " gelidus	-	106	23	64	11	70	-	4	-	3	14	307	3	9	-	2	21
22	" " sitiens	139	161	-	21	-	-	-	99	-	95	-	46	-	9	-	183	22
23	" " vishnui-gr.	-	179	15	119	11	370	-	90	-	65	19	95	3	4	-	8	23
24	" " bitaeniorhynchus-gr.	-	-	4	1	-	1	-	-	-	(1)	4	2	-	1	-	-	24
25	" (Lop) variatus	-	-	-	-	-	-	-	-	-	-	-	-	4	3	-	-	25
26	" " sp. A	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	26
27	" " sp. B	-	-	-	-	-	-	-	1	-	-	7	-	1	-	-	-	27
28	" " sp. C	-	-	-	-	-	-	-	-	-	-	6	-	-	-	-	-	28
29	" (Cui) spathifurca	-	-	-	-	-	-	-	-	-	-	-	-	31	-	-	-	29
30	" (Lut) fuscanus	1	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-	30
31	" " halifaxii	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	31
32	Ae (Stg) aegypti	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	32
33	" " albopictus	-	-	16	-	44	1	-	-	-	-	50	1	-	-	-	-	33
34	" " sp.	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	34
35	" (Adm) culicinus	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	35
36	" " vexans nocturnus	-	1	-	2	-	4	-	-	-	-	-	-	-	-	-	-	36
37	" " sp.	-	-	-	1*	-	-	-	-	-	-	-	-	-	-	-	-	37
38	" (Neo) lineatopennis	-	-	-	2	-	11	-	3	-	-	-	-	1	-	-	-	38
39	" (Lor) sp.	-	70	-	1	-	1	-	2	-	4	22	43	-	-	-	44	39
	Total	275	810	179	396	135	914	-	570	-	675	127	684	51	242	-	316	

* Collected during March 1979
( ) Male

(2) Vector or Suspected Vector Species of Human Diseases

1 Malaria vectors

a. Suspected primary vector

An sundaicus has been proved to be one of the main vectors in Java. Among the Anopheline species of the Project Area, this species is definitely dominant in the region close to the sea coast.

So-called fresh water form of sundaicus reported from Sumatra (Swellengrebel & Rodenwaldt, 1932) has not been found in the Project Area.

b. Suspected secondary vectors

1) An lesteri (subsp. anthropophagus) is known as the principal vector in Middle and South China. In Japan, this species is doubted to have played an important role in epidemic of the past indegenous malaria (vivax). On the contrary, in Philippines (subsp. lesteri) and Malaya and Borneo (subsp. paraliae), it is not thought to be a significant vector. This species has not been known from Sumatra before the quite recent report by O'Connor, 1980, and its vector status has not been studied here. Because of its relative abundance in the region near the sea coast with its breeding places in grassy ground pools, and high anthropophilism (apparently higher than in Malaysian paraliae, and higher than in sinensis), this species should be studied further for its vector potentiality.

2) An kochi. During 1921 to 1927, Dutch workers verified natural infection of this mosquito in North Sumatra (Kisaran, Sungai Baleh, Sungai Tuan)and obtained the infection rate from 1.00 to 5.08% (ex Swellengrebel & Rodenwaldt, 1932). This species is not very many in the Project Area, inhabiting ground pools of the inland area, thus should be noted as one of the secondary vectors.

3) An nigerrimus

4) An annularis

Above two species have been proved natural infection by malaria parasite, and nigerrimus is considered as the principal vector in certain areas (after Foot & Cook, 1959). However, they are rather rare in the Project Area, thus they might not be important vectors.

5) An sinensis. This widely spread Asian species has been regarded as an important malaria vector. Recent workers, however, tend to deny its vector status. It was verified in South China. In Thailand, it was reported that there was no substantiated data available that incriminate sinensis as a vector of malaria or other human pathogens (Harrison & Scanlon, 1975).

2 Vectors of diseases other than malaria

a. Filaria vectors

1) Ma uniformis

2) Ma bonneae

3) Cx pipiens quinquefasciatus

Though filariasis is not found in the project area, it has been known from adjacent areas, e.g., Bandar Kalipah in Deli Serdang, etc. Possible transmission may take place by transmigration of patients to the area, because an efficient vector, Ma uniformis, is abundant throughout the project area and it is one of the most severe man-biters.

b. Japanese encephalitis vectors

1) Cx fuscocephala

2) Cx gelidus

3) Cx pseudovishnui

4) Cx tritaeniorhynchus

5) Cx bitaeniorhynchus

Japanese encephalitis has not been reported in the Project Area. It cannot be said, however, not to be one of the cryptic diseases in the area. The vector mosquitos, tritaeniorhynchus, gelidus and fuscocephla are the most abundant mosquitos in the project area. It may always be necessary to pay attention to this disease and its vector.

c. Dengue and dengue haemorragic fever vectors

1) Ae aegypti

2) Ae albopictus

The main vector, Ae. aegypti is rare in the Project Area.

(3) Larval Habitats

Accurate knowledge on larval breeding places may usually give ideas for effective control methods. Habitats of larvae of all mosquito species in the Project Area have been checked along with the faunal survey, and they were confirmed for 36 species.

The Project Area may be roughly divided into 3 categories by the environmental conditions for mosquitos, viz., ① Coastal brackish water area, ② Inland rice field area, and ③ Rubber and oil-palm plantation area.

In the coastal brackish water area, Cx sitiens and An sundaicus are abundantly bred from temporary ground pools, and Ae (Lor) sp. from nipah and mangrove marsh. The inland rice-field area is characterized by abundance of An sinensis, An vagus, Cx fuscocephala, Cx gelidus, Cx tritaeniorhynchus, Ma uniformis and Ma indiana. They are bred in rice-field or temporary or permanent ground pools. Container-breeders are relatively few in the Project Area; only Ae albopictus is common throughout the Area, however, it is especially numerous in rubber and oil-palm plantation area.

Details of larval breeding places for each species are shown in Table 3.

(4) Mosquito Reference Collection

In medical entomology, correct identification of species is essential, and laboratory technician as well as entomologists must have this ability. A standard reference collection of medically important insects must be always kept in the laboratory for training them and occasional reference. For this purpose, about 2,000 mounted and identified adult mosquito specimens were arranged in taxonomical order, kept in Vector-Borne Diseases Subdirectorate, and are being utilized by the mosquito workers.

(5) Taxonomic Key for Identification of Anopheline Species of the Project Area - Adults and Larvae

Eleven species of Anopheles have been found in the Project Area. Keys for idenfitication of adults and larvae of them were prepared by K. Tanaka (Appendices 1 & 2).

For adults Anopheline mosquitos of whole Indonesia, consult O'Connor and Arwati, 1979. This may also be utilized in this area, and its illustrations appear to be especially useful. More excellent and comprehensive keys are those included in Reid, 1968. Utilizing both those keys and the reference collection of mosquitos, anybody who concerns entomology will be able to identify Anopheline mosquitos of the Project Area.

(Kazuo Tanaka: 1979. Jan. 18 ~ 1981. Jan. 17)

Table 3 Habitats of Mosquito Larvae

No.	Mosquito species	Ground water										Containers								Species No.
		Ditch	Ground pool	Hoof print	Marsh	Pond	Rice field	Rice field, fallow	Road-side pool	Shallow well	Swamp	Coconut shell	Concrete tank	Fallen leaf	Stump, aren	Stump, bamboo	Stump, banana	Stump, nibung	Tree hole	
1	An (Ano) argyropus	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	1
2	" " lesteri	-	+	-	-	+	+	+	+	+	-	-	-	-	-	-	-	-	-	2
3	" " peditaeniatus	-	-	-	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	3
4	" " sinensis	+	+	-	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-	4
5	" " baezai	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	5
6	" (Cel) kochi	-	-	+	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	6
7	" " sundaicus	+	+	-	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	7
8	" " vagus	+	+	+	-	+	+	+	+	-	+	-	-	-	-	-	-	-	-	8
9	Fi minima	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	9
10	Hi (Him) aurea	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	10
11	" " chamberlaini	-	+	-	-	+	-	+	+	-	-	-	-	-	-	-	-	-	-	11
	" " " metallica	-	-	-	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-	
12	Cx (Cux) pipiens quinquefasciatus	-	+	-	-	-	-	-	+	-	-	-	+	-	+	-	-	-	-	12
13	" " fuscocephala	+	+	+	-	+	+	-	-	-	+	-	-	-	-	-	-	-	-	13
14	" " gelidus	+	+	-	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-	14
15	" " sitiens	+	+	-	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	15
16	" " barraudi	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	16
17	" " vishnui-group*	-	+	-	+	+	+	+	+	-	+	-	-	-	-	-	-	-	-	17
18	" " bitaeniorhynchus	-	-	-	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-	18
19	" " sp. (bitaeniorhynchus-gr.)	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	19
20	" (Lop) variatus	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	20
21	" " sp. B	-	-	-	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	21
22	" " sp. C	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	22
23	" (Cui) spathifurca	-	+	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	23
24	" (Lut) fuscanus	+	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	24
25	" " halifaxii	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	25
26	Ae (Stg) albopictus	-	-	-	-	-	-	-	-	-	-	+	-	+	+	+	+	+	+	26
27	" " sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	27
28	" (Adm) culicinus	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	28
29	" (Neo) lineatopennis	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	29
30	" (Lor) sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	30
31	Ur (Pfc) sp. B	-	-	-	-	-	+	-	-	-	+	-	-	-	-	-	-	-	-	31
32	" (Ura) lateralis	-	+	-	-	-	+	-	-	-	+	-	-	-	-	-	-	-	-	32
33	" " micans	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	33
34	" " sp. E	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	34
35	Tx (Tox) sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	35
36	" " sp. B	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	36

* Cx pseudovishnui and Cx tritaeniorhynchus

APPENDIX 1

KEY TO THE SPECIES OF ANOPHELES OCCURRING IN THE ASAHAN PROJECT AREA - ADULTS

1	Wing with at most 1 or 2 white marks on costa except apical mark (Subgenus Anopheles)................	2
-	Wing with 3 or more white marks on coasta in addition to apical mark (Subgenus Cellia)..............	7
2	Palpus without pale bands; antenna without pale scales; abdominal sternum VII without a tuft of dark scales.................................	baezai
-	Palpus with pale bands; antenna with pale scales towards base; abdominal sternum VII with a tuft of dark scales (hyrcanus-group)............	3
3	White bands on hindtarsal segments narrow, not extending over the joints; abdominal segment VIII without dark scales at apex................	4
-	White bands on hindtarsal segments broad, at least 3rd band extending over the joint.................	5
4	Midcoxa with 2 patches of pale scales; wing usually with pale fringe spot at termination of cu-2; basal dark mark of cu short, separated by its own length or more from upper dark mark of a.............................	sinensis*
-	Midcoxa without patches of pale scales; wing without fringe spot at termination of cu-2; basal dark mark on cu long separated by less than its own length from upper dark mark of a......	lesteri**
5	Hindtarsal pale bands very broad, 3rd band more than 3/4 as long as segment IV; no pale scales on r between sub-costal and preapical pale spots....................................	argyropus
-	Hindtarsal pale bands seldom so broad, 3rd band less than 3/4 as long as segment IV; if 3rd band is 3/4 of segment IV (some specimens of peditaeniatus), r with numerous pale scales between subcostal and preapical pale spots..	6

6 Third hindtarsal pale band longer than segment V; humeral cross vein bare; remigium with a line of white scales along the front; no pale scales on basal half of costa; no fringe spot at termination of cu-2; no dark scales at apex of abdominal segment VIII; midcoxa without scale patches, but sometimes with an indistinct lower patch.................................... <u>peditaeniatus</u>

\- Third hindtarsal pale band usually shorter than segment V; humeral cross vein with dark scales; remigium without a line of white scales along the front; costa usually with one to a few scattered pale scales in basal half; often with a fringe spot at termination of cu-2; abdominal segment VIII with dark scales at apex; midcoxa usually with distinct pale scale patches............................ <u>nigerrimus</u>

7 Femora and tibiae speckled with pale spots............. 8

\- Femora and tibiae not speckled with pale spots.. 10

8 Palpus with 3 pale bands; proboscis dark; hindtarsi with narrow pale bands; tarsal segment V dark................................. <u>sundaicus</u>

\- Palpus with 4 or more pale bands; proboscis pale towards apex.................................. 9

9 Abdominal sterna II-VII with tufts of dark scales...................................... <u>kochi</u>

\- Abdominal sterna II-VII without tufts of dark scales.................................... <u>tessellatus</u>

10 Hindtarsal segments III-V white.................. <u>annularis</u>

\- Hindtarsal segments III-V dark or partly dark... 11

11 Proboscis with pale scales near apex; palpus with preapical dark band usually 1/4 or less as long as apical pale band.......................... <u>vagus</u>

\- Proboscis dark; palpus with preapical dark band usually 1/3 or more as long as apical pale band......................... [<u>indefinitus</u>] [<u>subpictus</u>]

* Male with white scales on basistyle

** Male without pale scales on basistyle

APPENDIX 2

KEY TO THE SPECIES OF ANOPHELES OCCURRING IN THE ASAHAN PROJECT AREA - LARVAE (COMPILED FROM REID, 1968 AND HARRISON & SCANLON, 1975)

1 Seta 2-C close together, or at most separated by a distance almost equal to that between 2 & 3-C (Subgenus Anopheles)........................... 2
- Seta 2-C wide apart and closer to 3-C than to one another (Subgenus Cellia)......................... 7

2 Abdomen without palmate setae (Seta 1 of abdomen simple)................................... baezai
- Abdomen with palmate setae at least one segments III-VII... 3

3 Seta 4-M small, with sinuate spreading branches arising close together at base..... peditaeniatus
- Seta 4-M with stiffer more erect or straight branches arising along central stem, or close together near base (argyropus)......................... 4

4 Seta 6-III usually with more than 20 branches; 6-I usually with more than 21 branches; 5-C with 17 or more branches; 5-II with 9-20 branches.. sinensis
- Seta 6-III rarely with more than 20 branches; 6-I usually with less than 21 branches; 5-C with 11-18 branches.................................... 5

5 Seta 8-C with 5-11 branches; 5-II with 6-10 branches.. lesteri
- Seta 8-C with 12-24 branches........................... 6

6 Seta 5-IV with 2-4 branches, usually 3; 5-III with 4-8 branches.............................. nigerrimus
- Seta 5-IV seldom with less than 5 branches; 5-III with 7-17 branches....................... argyropus

7 Seta 3-C brush-like............................ annularis
- Seta 3-C single and usually simple..................... 8

8 Seta 1-II fully palmate; filaments of other palmate setae long and slender, half or more as long as the blade; 9 & 10-T branched or feathered.. 9

\- Seta 1-II not fully palmate; filaments of other palmate setae not long, usually less than half as long as the blade; 9 & 10-T simple.. 11

9 Seta 3-C about 1/3 as long as 2-C; 4-C short and placed closer together than distance of 2-C, and located near 2-C.................................. <u>vagus</u>

\- Seta 3-C about 1/2 or more as long as 2-C; 4-C long, placed wide apart and far back............. 10

10 Seta 4-M most often with 3 (2-4) branches from near the base.............................. <u>sundaicus</u>

\- Seta 4-M most often with 2 (1-3) branches, if with a third branch, this usually arises from about half way along the seta......... [<u>indefinitus</u>] [<u>subpictus</u>]

11 Seta 1-P usually with 7-10 branches................. <u>kochi</u>

\- Seta 1-P smaller, with 2-5 branches........... <u>tessellatus</u>

III. BIOLOGICAL STUDY ON THE ADULT OF An. SUNDAICUS USING TRAP-HUT

Two mosquito trap-huts of magoon type were constructed at Perupuk, and had been operated twice a month for biological study on vector mosquitos since July 1980. One of the huts was later installed with 2 or 4 window-traps for the study of endo- or exophilic behaviour of blood-fed mosquitos.

The plan drawing of the hut and its general appearance with a window-trap are shown in Figure 1.

The merits of the use of trap-huts compared with man-biting collection are as follows: (1) Workers can avoid mosquito bites by using mosquito net, (2) Workers suffer no pain, (3) Workers can work with intervals and (4) Individual difference in skill is not necessary to consider.

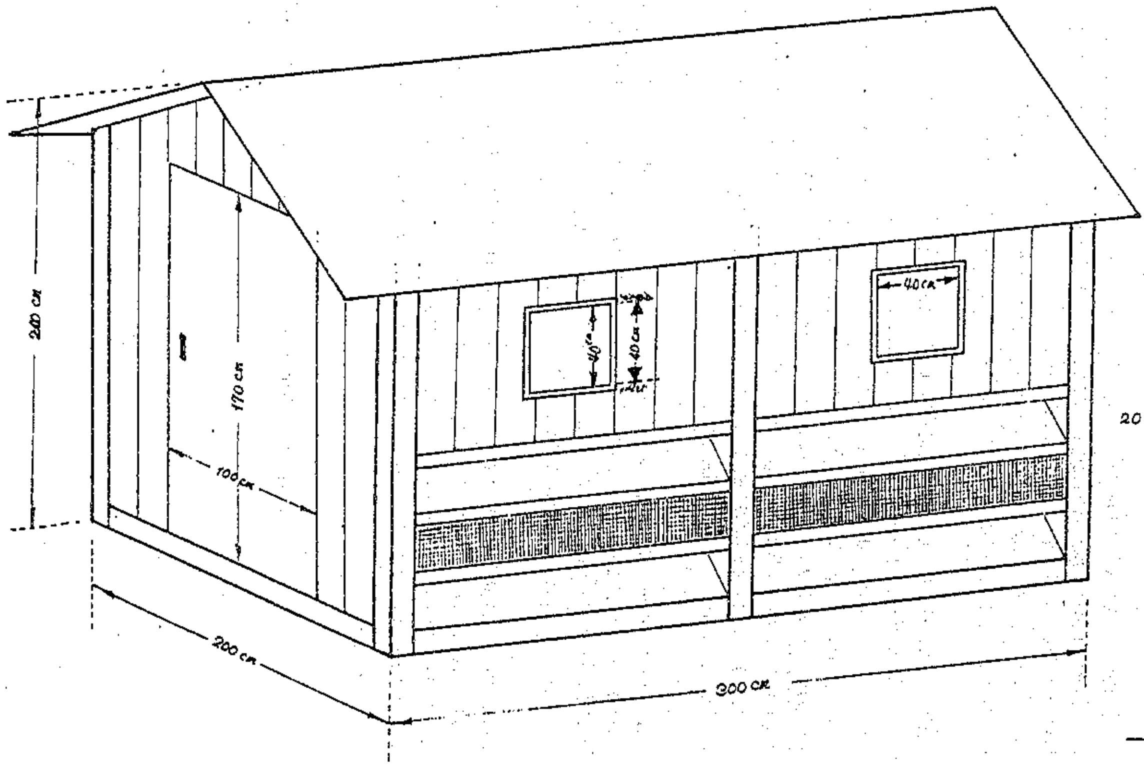
One trap-hut is baited with man and another with animals (5 cats for one time, 2 goats for 4 times). Obtained An sundaicus and the ratio between man-bait and animal bait are shown in Table 1. It tells that man attracted An sundaicus 13 times more than cat in one experiment, and 3.6 times more than goat in the total of 4 experiments. Fowl (bex.) attracted 128 mosquitos on August 5-6, among them only 1 was An sundaicus.

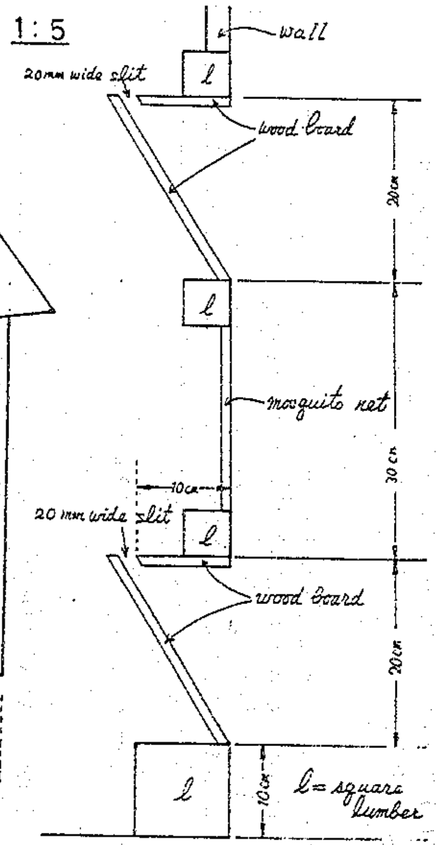
Through the rainy season (August to November), Mansonia spp. were attracted by man 5 times more than animals, while Culicine mosquitos other than Mansonia were attracted by animals 3.5 times more than man.

For the study of parasite rate in mosquitos, 40 An sundaicus obtained by trap-huts, were dissected and found one gravid female mosquito had 4 oocysts on midgut. The oocysts appears to be before bursting. Salivary gland was not checked.

(Kazuo Tanaka: 1979. Jan. 18 ~ 1981. Jan. 17)

1:20 Figure 1 Bait Trap-Hut





Mar. 2, 1980. K.T.

Table 1 Comparison of Host Preference of *Anopheles sundaicus* Collected by Man- & Animal-Baited Trap-Huts at Perupuk in the Rainy Season of 1980

Date	The Number of An sundaicus Trapped		Man/Animal Ratio
	Man	Animal	
VIII 19-20	13	1 (cat)	13.0
IX 10-11	18	13 (goat)	1.4
IX 23-24	38	6 (goat)	6.3
X 7-8	19	4 (goat)	4.8
XI 3-4	15	2 (goat)	7.5
Total of the last 4:	90	25 (goat)	3.6

IV. ECOLOGY OF MALARIA VECTORS

(1) Vector Mosquitos and Their Distribution in the Project Area

Preliminary surveys of malaria mosquitos and their population densities were carried out at the four selected villages in the project area in March and April 1980 (Fig. 1). In this area, a total of six species of anopheline mosquitos were collected by the night catches, namely *Anopheles (Anopheles) argyropus* (Swellegrebel, 1914); *Anopheles (Anopheles) nigerrimus*, Giles, 1900; *Anopheles (Anopheles) peditaeniatus* (Leicester, 1908); *Anopheles (Anopheles) sinensis* Wiedemann, 1828; *Anopheles (Cellia) sundaicus* (Rodenwaldt, 1925) and *Anopheles (Cellia) tessellatus* Theobald, 1901. *An. sundaicus* was evidently dominant in the areas close to the coast line, such as Pangkalan Dodek, Medan and Perupuk, both during the dry season (March to April) and the rainy season (September to October) as shown in Table 1. Malaria cases were also detected from only the coastal areas of the sub-districts.

Perupuk was selected as the study area to obtain more detailed information on *An. sundaicus* related to malaria from the following reasons. (a) Man-biting density of *An. sundaicus* was highest there compared with other villages. (b) The densities of other anopheline species (mostly *An. sinensis* group) were lower than that of *An. sundaicus*. (c) A variety of environments for the habitat of *An. Sundaicus*, such as flora, topography, salinity etc., were found from the seashore to the inland in this village. People are living in various environments such as sand bank near the seashore or rice field area in inland as shown in Fig. 2.

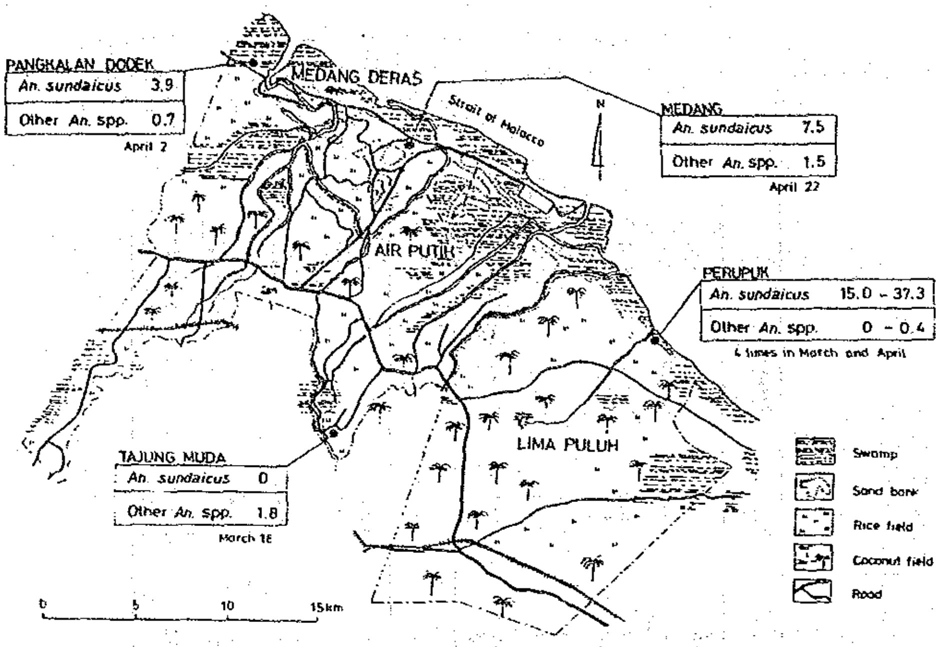


Figure 1 Man-hour Biting Density of Anopheline Mosquitos Observed at Four Stations During March and April, 1980

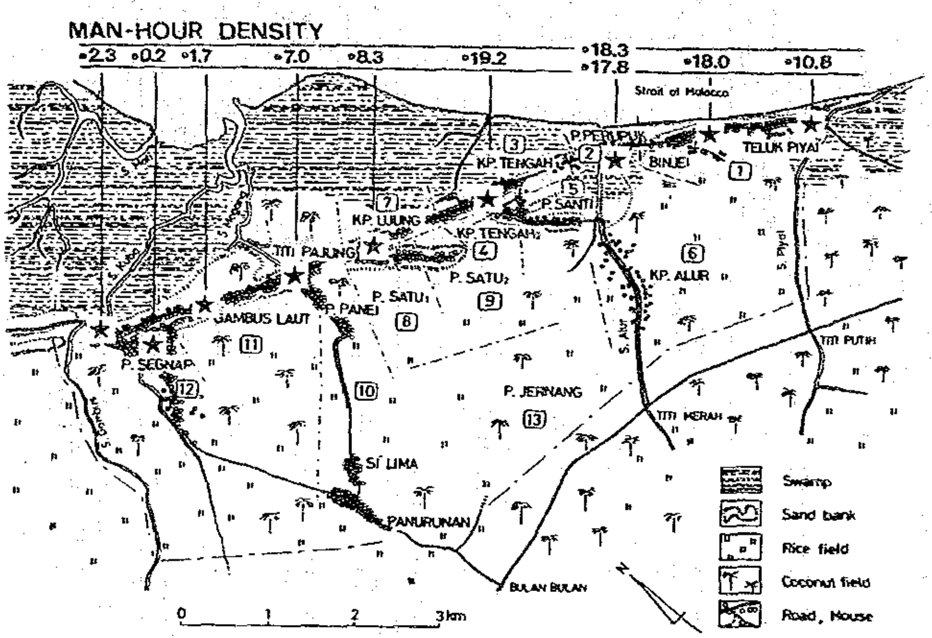


Figure 2 Man-hour Biting Density of Anopheles sundaicus Observed by Outdoor Collections in Different Blocks (□) of Perupuk, on August 5 (o) and August 19 (•), 1980 (2 Collectors Were Used for Each Site from 18:30 to 23:00.)

Table 1 Man-Hour Density of Mosquitos Caught by Biting Collection Outdoors or Indoors at Four Villages in the Sub-Districts, Air Putih, Medan Deras and Lima Puluh

(In the dry season)

Village	Date		*Anopheles sundaicus*	Other *An.* spp.	*Mansonia* spp.	*Culex* spp.	*Aedes* spp.	All
Tanjung Muda	Mar. 18	Outdoor	0.0	1.8*	16.0	12.8	0.0	30.6
		Indoor	0.0	2.0*	5.4	19.2	0.0	26.6
Pangkalan Dodek	Apr. 2	Outdoor	3.9	0.7*	1.3	18.6	4.0	28.6
		Indoor	1.2	0.2*	0.8	3.6	0.8	6.4
Medan	Apr. 22	Outdoor	7.5	1.5*	44.2	21.8	16.5	91.5
		Indoor	6.6	0.0	21.0	34.1	4.5	65.2
Perupuk	Mar.-Apr. (Min.-Max.)	Outdoor	15.0-37.3	0.0-0.4*	0.6-5.4	3.6-12.5	0.1-4.9	23.2-57.2
		Indoor	7.3-21.7	0.0	0.1-0.6	0.5- 3.1	0.0	7.9-25.4

(In the rainy season)

Village	Date		*Anopheles sundaicus*	Other *An.* spp.	*Mansonia* spp.	*Culex* spp.	*Aedes* spp.	All
Tanjung Muda	Sep. 16	Outdoor	0.0	4.0**	8.0	30.2	0.7	42.9
		Indoor	0.0	0.5**	2.6	9.2	0.0	12.3
Pangkalan Dodek	Oct. 14	Outdoor	2.4	3.0*	25.2	11.7	0.0	42.3
		Indoor	1.8	1.1*	11.3	3.9	0.0	18.1
Medan	Oct. 27	Outdoor	2.3	4.3*	135.9	4.1	11.3	157.9
		Indoor	0.2	0.4*	30.8	6.3	0.1	37.8
Perupuk	Sep.-Oct. (Min.-Max.)	Outdoor	6.1-29.7	3.3*-21.5*	14.6-229.4	6.3-34.9	0.3-4.8	31.4-285.7
		Indoor	5.0- 7.1	3.2*- 7.0*	29.1- 90.4	3.4-15.2	0.0-0.4	46.6-114.2

2 or 3 collectors were used from 18:30 to 23:00.
* : mostly *sinensis* groupe
** : mostly *peditaniatus*

This village had a population of over 6,000 and about 1,300 houses. Most villagers are engaged in fishery or farming, as shown in Table 2.

Table 2 The Number of People and Houses at Respective Blocks in Perupuk, 1979

	No. people	No. house	
Block [1]	789	159	Commonly Malay tribe, fisher (Blocks [1]–[9])
[2]	282	63	
[3]	419	79	
[4]	257	57	
[5]	178	70	
[6]	252	57	
[7]	252	60	
[8]	206	41	
[9]	181	41	
[10]	905	181	30% Java & Tapanuli tribe, farmer 70% Malay tribe, fisher
[11]	648	127	Commonly Malay tribe, fisher
[12]	771	166	Commonly Java tribe, farmer
[13]	872	176	Commonly Malay tribe, fisher
Total	6,012	1,277	

* The data were offered from the chief of village.

(2) Distribution of *An. sundaicus* in Perupuk

To study the distribution of the adult mosquito in Perupuk, the man-hour biting density of *An. sundaicus* was measured at nine spots as shown in Fig. 2. A high density was found only in Block No. I, II and III among Blocks of Perupuk. These results indicated that: (a) The breeding place of *An. sundaicus* is restricted to the areas close to the seashore. (b) The forest swamp area which is located in northern part of the village seems to be inadequate for their habitat. It is important that the distribution of the mosquito accorded to that of the malaria patients as mentioned later.

Fig. 3 illustrates the relative man-biting density of *An. sundaicus* to the density at the fixed station in Block II. The density was high in Block I and II but not in Block V. It could be supposed that malaria was endemic in a small area without spreading to the surroundings possibly due to the habit of *An. sundaicus* in the project area.

(3) Habitat of *An. sundaicus* Larvae

Twenty five ponds in Block I and II (each of them was shown with alphabets in Fig. 3) were examined for breeding of *An. sundaicus*. The relationship between the salinity of the pond water and the breeding of *An. sundaicus* based on the observations repeated eight-times from May to December indicated that the larvae were found not only in brackish water but also in fresh water though they appear more frequently in the former. The salinity of water in these ponds surveyed was always lower than 2% throughout the year, and the all fresh water ponds positive for larvae had been previously flooded by brackish water. The relationship between the salinity and breeding of *An. sundaicus*, had been reported without showing detailed figures, for example Sundararaman *et al*. (1957) 0.4 - 3.0% (optimum 1.5 - 2.0%, Mid Java), Russel *et al*. (1963) 0.6 - 0.8% (optimum), Ronnefeldt (1959) 1.3 - 1.8% (Mid Java) and Collins *et al*. (1979) 0.5 - 1.0% (in general, South Sulawesi).

MAP OI

MAP OF BLOCK 1, 2 AND 5 IN PERUPUK

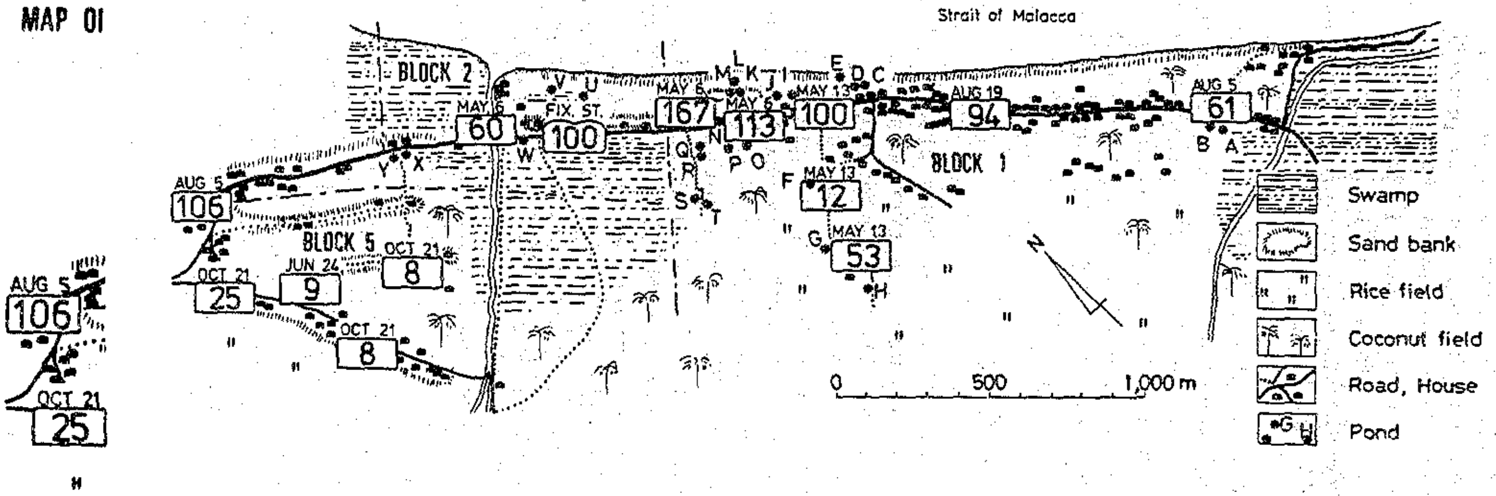


Figure 3 Comparison of Man-Biting Density of An. sundaicus Observed by Outdoor Collections at the Various Sites in Block 1, 2 and 5, Perupuk
Each value represents the relative density when that of fixed station is taken as 100.

Clusters of long fibred floating algae such as _Enteromorpha_ sp. or _Chaetomorpha_ sp. seem to provide a favourable breeding places for larvae of _An. sundaicus._ Many larvae were observed in the ponds in which these algae were present. However, the algae and the larvae were not always co-occuring. The larvae were occasionally found in the ponds where no algae had grown.

Survey on the relation between the location of ponds and the breeding of _An. sundaicus_ in Block I or II on July 15, showed that more larvae were found in ponds in sun than the ponds in shade. It is very likely that no breeding of _An. sundaicus_ in the forest swamps of mangrove which were located in the northern part of Perupuk was due to the shade.

(4) Host Preference of _An. sundaicus_

The host preference of the species at that place is one of the most important aspects of malaria transmission. Some observations were made to see the host preferences of _An. sundaicus_ in Perupuk by a simple method using man and animals siting side by side outdoors as blood sources. The blood-fed mosquitos on each host were collected directly by a human collector. The first observation using man, goat and buffalo showed that 71% of the total catches were from man, while the remainders were from buffalo and goat (Table 3). In the second observation using man and monkey, man was much more attractive compared with monkey. Our investigations as well as Collins _et al._ (1979) in South Sulawesi indicated that _An. sundaicus_ had a strong preferrence to man. However, according to Reid (1961), this species in Malaya was attracted in larger numbers to a calf than to two men. Thus, there seems to be geographic variations in the host preference.

The extent of contact between vector and host also depends largely on the availability of host. In this view point, the populations of potential hosts were censused in Block I and II of Perupuk. The numbers of human, goats and buffalos in this area were 1,071, 150 and 4 respectively. The population of monkey could not be estimated but possibly not large.

Table 3 Number of Mosquitos Attracted to Different Hosts per Hour

Observation 1 (June 3, 1980, Block I in Perupuk)

Host	*Anopheles sundaicus*	Other *An.* spp.	*Mansonia* spp.	*Culex* spp.	*Aedes* spp.	All
Human	33.5 (79)*	0.3	6.2	25.2	5.0	70.2
Buffalo	7.3 (17)	0	1.3	130.3	10.7	149.6
Goat	1.7 (4)	0.7	4.7	35.7	7.0	49.8
	42.5 (100)	1.0	12.2	191.2	22.7	269.6

Observation 2 (September 2, 1980, Block II in Perupuk)

Host	*Anopheles sundaicus*	Other *An.* spp.	*Mansonia* spp.	*Culex* spp.	*Aedes* spp.	All
Human	24.8 (90)	31.7	55.7	6.3	0.7	119.2
Monkey*	2.7 (10)	6.3	22.7	1.3	0	33.0
	27.5 (100)	38.0	78.4	7.6	0.7	152.2

Each host was exposed to mosquito bites outdoors from 18:30 to 23:00.
*: *Macaca fascicularis*

(5) Seasonal Fluctuation in the Density of An. Sundaicus

The number of An. sundaicus coming to bite a man per hour so called man-hour biting density, is obviously an important factor in the malaria transmission. Fig. 4 shows the fluctuation of the man-hour density of An. sundaicus caught by biting collection outdoors and carried out at the fixed station in Block II of Perupuk, from March 1980 to January 1981. The density outdoors reached to more than 45 per hour in late May 1980 and remained at such a high level for a period of 4-5 weeks. The highest density was observed in late May. The density declined in July to about 20 and stayed at this level with some minor fluctuations until December. The lowest density of 6.1 was observed on September 10, when it rained and temperature declined to 22.5-23.5°C.

The seasonal trend of malaria cases corresponded quite well to that of the mosquito density with a time lag of one to two months. The temperature and the humidity in this area were almost constant throughout the year but the rainfall fluctuated as shown in Fig. 5, suggesting that the rainfall affected to the mosquito density in Perupuk.

Fig. 5 shows the seasonal fluctuation of An. sundaicus observed at two different localities. The upper indicates the result in Tjilatjap, south coast area of Mid Java (after Sundararaman, 1958) where there were three peaks, two of which were observed in April 1954 or May 1955 at the end of dry season, and another in October and November 1954, the rainy season. In South Sulawesi, there were two peaks in the two years (Collins et al., 1979). One of them was observed in February and March 1974, the dry season and another in June and July 1975, the rainy season. These results indicate that there is no direct relationship between the seasonal fluctuation of the mosquito density and the rainfall.

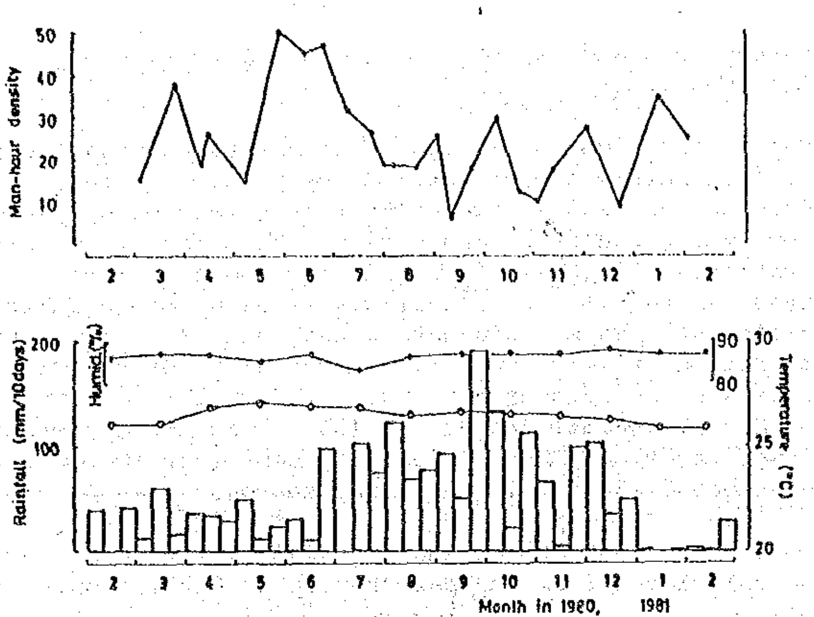


Figure 4 Comparison of the fluctuation of man-hour density *An. sundaicus* caught by biting collections outdoors at Block 2 in Perupuk (2 or 3 collectors were used from 18:30 to 23:00), and the meteorological data recorded at Lima Puluh by Sampali Climatological station, Medan.

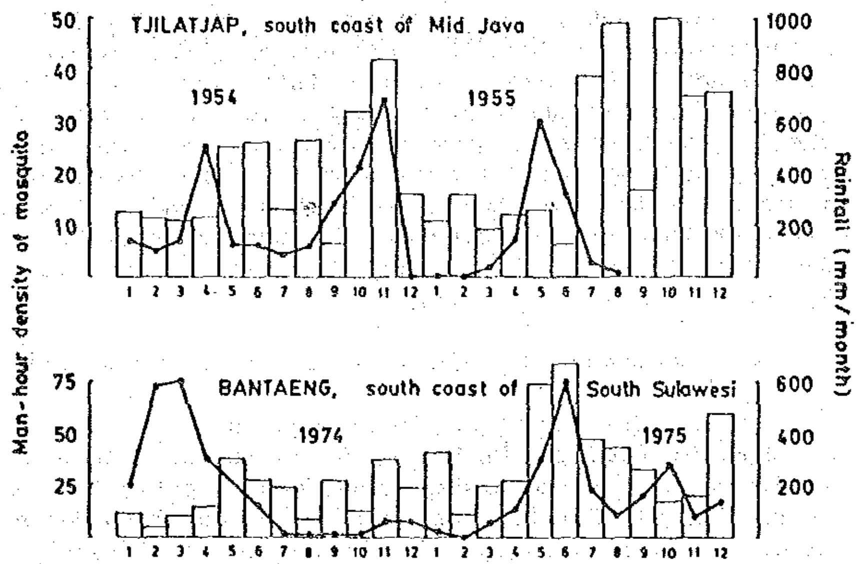


Figure 5 Seasonal fluctuations of the density of *An. sundaicus* and the rainfall at the two locations in Indonesia. Mosquito data were cited from Sundararaman (1958) and Collins *et al.* (1979). Rainfall data were offered by Sampali Climatological Station, Medan.

(6) Parous Rate and Expectation of Infective Life of <u>An</u>. <u>Sundaicus</u>

One of the figures bearing on longevity of mosquito population in nature are proportions of parous females, which have laid eggs at least once. The parous rate of An. sundaicus population caught by man-biting collection at the fixed station in Block II of Perupuk are shown in Table 4. The parous rate differed significantly among the populations of different date but did not differ much among populations collected at different time in one night or the different site such as outdoor and indoor. Higher rates were observed on May 27 (48.1%) and July 8 (55.5%) in the dry season, and lower rates on August 5 (34.7%), September 10 (32.7%) and November 3 (37.5%) in the rainy season.

Davidson (1954) showed that the daily survival rates (p) can be calculated from the parous rate by the following formula;

$$p = \sqrt[r]{q}$$

where q is the parous rate of the population and r is the gonotrophic cycle (days) which means one complete round of ovarian development in the mosquito. Assuming the duration of the gonotrophic cycle of An. sundaicus is 2 days throughout the year according to the data shown by Sundararaman et al. (1957) and the sporogonic period being 12 days according to Garnham (1966), the values of expectation of infective life are shown in Table 5. For example, the population of July 8 had a long expectation of infective life which is 45 times longer than that of September 10. As mentioned above, the longevity of a mosquito has a great influence on its potency as a vector. The rapid decline in the malaria incidence rate indicated as infant cases and as the parasitized erythrocytes density of each patient from August to December accorded well to the decreasing of longevity of the mosquito.

(7) Outdoor and Indoor Man-Biting Activity of An. sundaicus

The biting activity of An. sundaicus throughout the night is shown in Fig. 7. On March 25-26, it was fine and little windy throughout the night. The feeding activity outdoors started slowly but rose steadily each hour with minor fluctuation until heavy biting occurred at mid-night. Indoors few of them bit before 20:00 and after 5:00 though they bit more or less uniformly throughout the night. However, it should be noted that only a light rain or breeze prevented the outdoor biting to some extent and then

Table 4 Parous Rate (%) of An. sundaicus Caught by Man-Biting Collection at Block II in Perupuk, 1980-1981

Date	Site	Each quarter in the night 1	2	3	4	Sub-total	Total
May 27	Outdoor	47.1 (104)	50.8 (130)	31.8 (20)	23.1 (13)	46.5 [40-53] (269)	48.1 [42-54] (420)
	Indoor	62.5 (16)	60.0 (15)	50.0 (68)	46.2 (52)	51.0 [43-59] (151)	
Jul 8	Outdoor	55.4 (184)	56.1 (41)			55.6 [49-62] (225)	55.5 [50-61] (326)
	Indoor	55.3 (76)	56.0 (25)			55.4 [45-65] (101)	
Aug 5	Outdoor	28.3 (46)	41.3 (46)			34.7 [25-45] (92)	34.7 [25-45] (92)
Sep 10	Indoor	34.2 (38)	28.6 (14)			32.7 [20-47] (52)	32.7 [20-47] (52)
Nov 3	Outdoor	25.0 (16)	40.0 (116)	35.5 (31)	34.9 (43)	36.9 [30-44] (206)	37.5 [32-44] (253)
	Indoor	33.3 (6)	38.9 (18)	46.2 (13)	40.0 (10)	40.4 [26-56] (47)	
Jan 13	Outdoor	37.2 (86)	37.6 (85)			37.4 [30-45] (171)	43.3 [37-50] (238)
	Indoor	59.6 (47)	55.0 (20)			58.2 [45-70] (67)	

( ) : Number of mosquitoes dissected
[ ] : Confidence interval at 95% probability level

Table 5 Expectation of Infective Life for the Sporogonic period 12 days calculated from the parous rate of each mosquito population

Date	Parous rate	Survival rate per day (p)	p^{12}	$1/(-\log_e p)$	$p^{12}/(-\log_e p)$
May 27	.481 (1.5)	.6935 (1.2)	.0124 (10.3)	2.733 (1.5)	.0339 (15.4)
July 8	.555 (1.7)	.7450 (1.3)	.0292 (24.3)	3.397 (1.9)	.0992 (45.0)
Aug. 5	.347 (1.1)	.5890 (1.0)	.0017 (1.4)	1.889 (1.1)	.0032 (1.5)
Sep.10	.327 (1.0)	.5718 (1.0)	.0012 (1.0)	1.789 (1.0)	.0022 (1.0)
Nov. 3	.375 (1.1)	.6123 (1.1)	.0028 (1.1)	2.039 (1.1)	.0057 (2.6)
Jan.13	.433 (1.3)	.6580 (1.2)	.0066 (5.5)	2.389 (1.3)	.0157 (7.1)

Assuming that the duration of the gonotrophic cycle throughout the seasons is 2 days, and the sporogonic period is 12 days.
( ): Index defined on the value at Sep. 10 = 1.0

changed that pattern as seen on May 27-28 or November 3-4 in Fig. 7.

It is also important to find out where An. sundaicus is biting, indoors or outdoors. This factor also may vary with changing climatic conditions as seen on May 27-28 (Fig. 7). However, the results show that considerably larger number of mosquitos were caught outdoors than indoors. The rate of An. sundaicus caught indoors was 29% of total in the dry season, 26% in the rainy season. According to Reid (1968), the indoor biting rates of malaria vectors in Malaysia were 76% for An. campestris, 42% for An. balabacensis, 29% for An. sundaicus and 23% for An. maculatus.

(8) Resting Behaviour of An. sundaicus after Taking Blood

The information on the resting place of mosquitos is important not only in order to select appropriate chemical control measure but also to obtain population indices. In these view points, the collection in the early morning was tried by 6 collectors in Block II on March 26, 1980. But no An. sundaicus could be found inside of 8 houses though there were many biting mosquitos around there until 5:00 as shown in Fig. 7. As this result might indicate that An. sundaicus in this area was exophilic, another observation was carried out.

The procedure was as follows: The legs of two men were exposed for mosquito to bite inside house without catching mosquitos for 20 minutes, soon after which the two collectors searched for 10 minutes and catched all resting mosquitos on the walls, which were made of bamboo. This collection was repeated nine times for 18:30 to 23:00 and its result is shown in Fig. 8. An. sundaicus found resting indoors after blood sucking were only 6.9% of the total biting individuals and those were very nervous and flew when collectors try to catch. On the contrary, 34.7% of other species of mosquitos were found resting indoors.

(Takaya Ikemoto: 1980. Jan. 31 - 1981. Jan. 30)

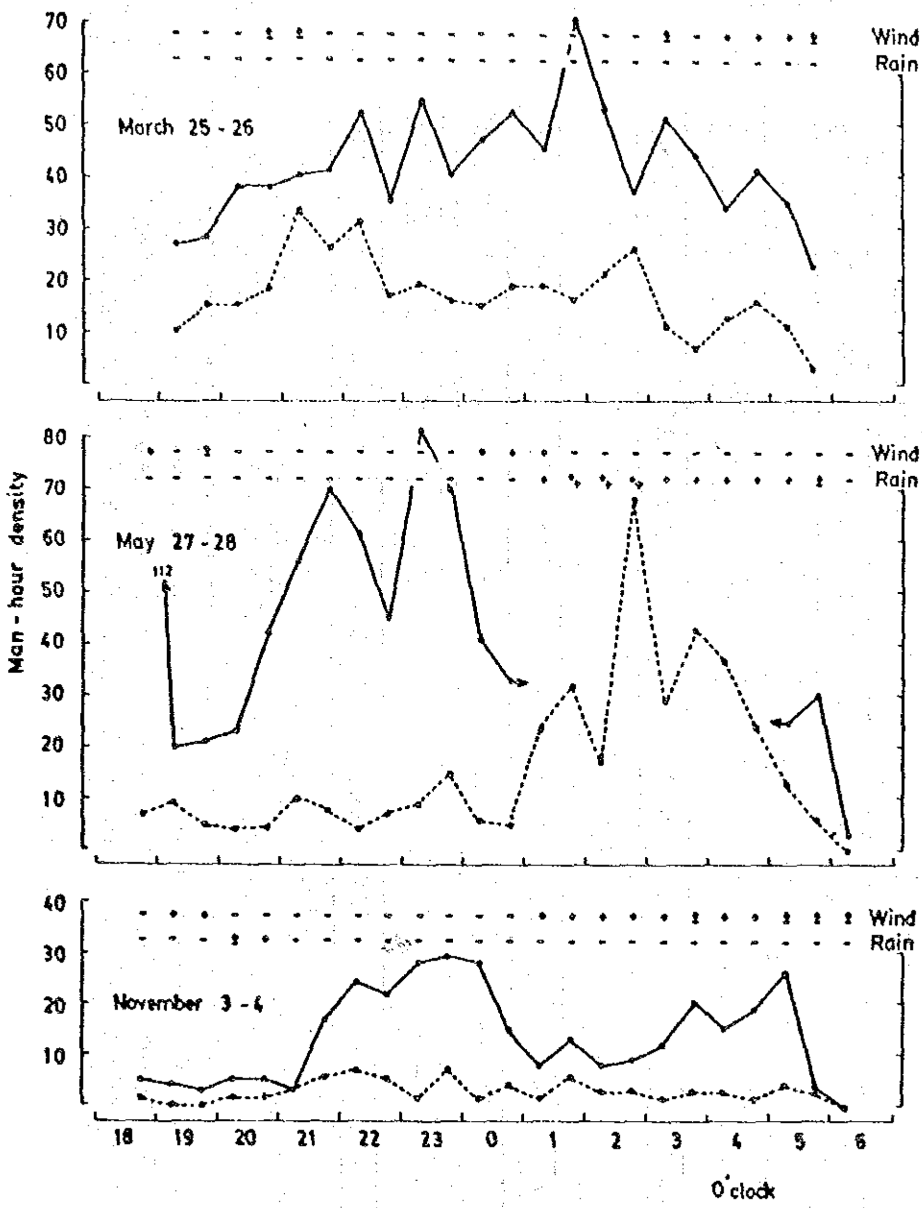


Figure 7 Nocturnal man biting activity of An. sundaicus at Block 2 in Perupuk; the numbers indicate the average of 3 persons exposed to mosquito bites per hour either outdoors (●——●) or indoors (●----●).

An. sundaicus

	18:30–18:50	18:50–19:00	19:00–19:20	19:20–19:30	19:30–19:50	19:50–20:00	20:00–20:20	20:20–20:30	20:30–20:50	20:50–21:00	21:00–21:20	21:20–21:30	21:30–21:50	21:50–22:00	22:00–22:20	22:20–22:30	22:30–22:50	22:50–23:00	Total
No. of biting mosquito[1] (A)	6		14		14		17		19		36		6		13		20		145
No. of resting mosquito[2] fed (B)		0		1		2		2		1		1		1		2		0	10
No. of resting mosquito[2] unfed		0		0		0		0		0		1		0		0		0	1
(B) / (A) x 100	0		7.1		14.3		11.8		5.3		2.8		16.7		15.4		0		6.9

Culex & Mansonia spp.

	18:30–18:50	18:50–19:00	19:00–19:20	19:20–19:30	19:30–19:50	19:50–20:00	20:00–20:20	20:20–20:30	20:30–20:50	20:50–21:00	21:00–21:20	21:20–21:30	21:30–21:50	21:50–22:00	22:00–22:20	22:20–22:30	22:30–22:50	22:50–23:00	Total
No. of biting mosquito[1] (A)	0		28		26		31		35		27		28		25		19		219
No. of resting mosquito[2] fed (B)		0		5		6		8		11		9		13		11		13	76[3]
No. of resting mosquito[2] unfed		0		0		5		8		4		2		5		0		5	29[4]
(B) / (A) x 100	–		17.9		23.1		25.8		31.4		33.3		46.4		44.0		68.4		34.7

Figure 8 Biting and resting behaviour of An. sundaicus compared with that of some other spp. in the rural house, Perupuk, July 23, 1980

1): 2 volunteers were used as the blood sources for each 20 minutes. Any mosquitoes were not collected.

2): 2 collectors were used for each 10 minutes after exposure to mosquito bites.

3): Ma. uniformis (66), Ma. indiana (3), Ma. annulifera (1), Cx. sitiens (5), Cx. gelidus (1).

4): Ma. uniformis (16), Ma. indiana (3), Cx. sitiens (5), Cx. gelidus (2), Cx. vishnui-gr (3).

V. ENTOMOLOGICAL STUDIES ON ANOPHELES SUNDAICUS BEFORE AND AFTER THE DDT RESIDUAL SPRAY IN A PILOT STUDY AREA, PERUPUK VILLAGE

Entomological and ecological surveys on the malaria vector have been carried out since 1980 at Village Perupuk which was chosen as a pilot study area for the Malaria Control Program. The preliminary survey showed that *Anopheles sundaicus* has played an important role as the malaria vector in the pilot area.

Although the most suitable malaria control measure for the respective area have to be selected, the DDT residual spray is only the method to be adopted in North Sumatra up to the present. The most suitable timing for the spray was late May according to the results of the preliminary survey, but the spray was made in early June 1981. And evaluation of the effect of the spray in Perupuk has been continued by Japanese Experts in cooperation with Indonesian Counterparts.

(1) Seasonal Prevalence of *An. sundaicus*

In 1981, surveys were conducted only within Lorong (Sub-village) I and II, coastal parts in Perupuk according to the results in the preceding year.

Man-biting collectors were performed in the nighttime at least twice a month for estimating the seasonal prevalence of adult mosquitos in the survey area. Both outdoor and indoor collections were done on every sampling day. Tables 1 and 2 show the man-hour density of *An. sundaicus* and other species in 1981. As shown evidently in the tables, the relative density of *An. sundaicus* was the highest among the species collected both in outdoor and indoor collections. Furthermore, it should be emphasized that the density of *An. sundaicus* was usually higher than that of other anopheline mosquitos.

Table 1 Man-Hour Density of Mosquitos Collected by Man-Biting Collection at Lorong II in Village Perupuk, Lima Puluh in 1981

Outdoor collection

Date of collection	*Anopheles sundaicus*	Other *Anopheles* spp.	*Mansonia* spp.	*Culex* spp.	*Aedes* spp.	All
Jan. 13	34.4 (20.2)	15.6 (9.2)	31.9 (18.7)	87.6 (51.5)	0.7 (0.4)	170.2 (100)
Feb. 2	25.2 (25.0)	7.2 (7.2)	10.1 (10.0)	57.1 (56.7)	1.1 (1.1)	100.8 (100)
Feb. 24	10.1 (41.6)	1.0 (4.1)	4.6 (18.7)	6.8 (27.9)	1.9 (7.8)	24.3 (100)
Mar. 10	10.7 (55.5)	0.1 (0.6)	1.6 (8.1)	4.8 (24.9)	2.1 (11.0)	19.2 (100)
Mar. 17	31.1 (68.0)	0.1 (0.2)	5.8 (12.6)	5.6 (12.1)	3.2 (7.0)	45.8 (100)
Mar. 24	10.6 (64.6)	0.1 (0.7)	0.3 (2.0)	2.6 (15.7)	2.8 (17.0)	16.3 (100)
Apr. 6	6.9 (65.3)	0	0.2 (2.1)	2.6 (24.2)	0.9 (8.4)	10.6 (100)
Apr. 21	31.7 (67.5)	0.2 (0.5)	1.9 (4.0)	11.4 (24.4)	1.7 (3.6)	46.9 (100)
May 12	38.0 (41.3)	0.2 (0.2)	16.2 (17.6)	15.0 (16.3)	22.6 (24.5)	92.0 (100)
May 18	25.2 (15.7)	0.6 (0.4)	20.1 (12.5)	61.1 (38.1)	53.6 (33.4)	160.6 (100)
May 26	36.8 (69.4)	0	2.1 (4.0)	11.8 (22.2)	2.3 (4.4)	53.0 (100)
Jun. 10	66.9 (44.4)	0.9 (0.6)	24.1 (16.0)	48.8 (32.4)	9.9 (6.6)	150.6 (100)
Jun. 16	75.9 (55.8)	0.4 (0.3)	13.7 (10.1)	38.6 (28.4)	7.4 (5.5)	136.0 (100)
Jul. 8	27.3 (71.3)	0	0.2 (0.4)	10.2 (26.5)	0.7 (1.7)	38.3 (100)
Jul. 21	8.3 (57.3)	0	0.1 (0.8)	3.6 (24.4)	2.6 (17.6)	14.6 (100)
Aug. 12	14.2 (39.8)	0	1.0 (2.8)	19.7 (55.0)	0.9 (2.5)	35.8 (100)
Aug. 25	9.4 (75.9)	0	0.1 (0.9)	2.6 (20.5)	0.3 (2.7)	12.4 (100)
Sep. 9	18.1 (21.7)	0.1 (0.1)	4.1 (4.9)	57.4 (68.8)	3.7 (4.4)	83.4 (100)
Sep. 22	28.7 (16.7)	1.0 (0.6)	11.1 (6.5)	128.6 (74.7)	2.9 (1.7)	172.2 (100)
Oct. 7	26.4 (17.7)	5.9 (3.9)	25.8 (17.3)	83.8 (56.1)	7.4 (5.0)	149.3 (100)
Oct. 27	26.4 (22.9)	29.2 (25.3)	3.1 (2.7)	52.2 (45.2)	4.7 (4.0)	115.7 (100)
Nov. 11	31.2 (30.1)	23.0 (22.1)	25.3 (24.4)	17.9 (17.2)	6.4 (6.2)	103.9 (100)
Nov. 25	33.8 (39.8)	13.3 (15.7)	16.1 (19.0)	13.3 (15.7)	8.3 (9.8)	84.9 (100)
Dec. 8	56.1 (46.4)	15.9 (13.1)	25.8 (21.3)	21.2 (17.5)	2.0 (1.7)	121.0 (100)

Table 2 Man-Hour Density of Mosquitos Collected by Man-Biting Collection at Lorong II in Village Perupuk, Lima Puluh in 1981

Indoor collection

Date of collection	Anopheles sundaicus	Other Anopheles spp.	Mansonia spp.	Culex spp.	Aedes spp.	All
Jan. 13	8.3 (13.5)	3.0 (4.9)	9.7 (15.7)	40.6 (65.9)	0	61.6 (100)
Feb. 2	4.2 (31.4)	0.4 (3.3)	2.0 (14.9)	6.7 (49.6)	0.1 (0.8)	13.4 (100)
Feb. 24	3.8 (63.0)	0.6 (9.3)	0.8 (13.0)	0.9 (14.8)	0	6.0 (100)
Mar. 10	2.6 (52.3)	0	0.7 (13.6)	1.6 (31.8)	0.1 (2.3)	4.9 (100)
Mar. 17	3.4 (58.5)	0	1.6 (26.4)	0.9 (15.1)	0	5.9 (100)
Mar. 24	2.8 (51.0)	0.1 (2.0)	0.3 (6.1)	1.8 (32.7)	0.4 (8.2)	5.4 (100)
Apr. 6	3.1 (37.3)	0	1.2 (14.7)	4.0 (48.0)	0	8.3 (100)
Apr. 21	8.6 (65.3)	0	0.3 (2.5)	3.8 (28.8)	0.4 (3.4)	13.1 (100)
May 12	17.0 (66.2)	0	1.1 (4.3)	5.7 (22.1)	1.9 (7.4)	25.7 (100)
May 26	12.9 (76.3)	0	0.7 (4.0)	2.8 (16.6)	0.6 (3.3)	16.9 (100)
Jun. 10	15.6 (47.3)	0.1 (0.3)	3.1 (9.5)	13.6 (41.2)	0.6 (1.7)	32.9 (100)
Jun. 16	6.2 (40.0)	0	3.6 (22.9)	5.1 (32.9)	0.7 (4.3)	15.6 (100)
Jul. 8	6.7 (84.5)	0	0	1.1 (14.1)	0.1 (1.4)	7.9 (100)
Jul. 21	0.8 (58.3)	0	0	0.3 (25.0)	0.2 (16.7)	1.3 (100)
Aug. 12	2.3 (56.8)	0	0.1 (2.7)	1.6 (37.8)	0.1 (2.7)	4.1 (100)
Aug. 25	1.1 (35.7)	0	0	0.9 (28.6)	1.1 (35.7)	3.1 (100)
Sep. 9	3.7 (32.7)	0	0.4 (4.0)	7.1 (63.4)	0	11.2 (100)
Sep. 22	2.7 (3.4)	0.2 (0.3)	2.6 (3.3)	72.2 (91.9)	0.9 (1.1)	78.6 (100)
Oct. 7	3.0 (22.0)	0.1 (0.8)	4.9 (35.8)	5.2 (38.2)	0.4 (3.3)	13.7 (100)
Oct. 27	6.8 (32.5)	3.3 (16.0)	1.0 (4.8)	9.1 (43.6)	0.7 (3.2)	20.9 (100)
Nov. 11	3.0 (30.7)	0.3 (3.4)	2.9 (29.6)	3.1 (31.8)	0.4 (4.6)	9.8 (100)
Nov. 25	6.7 (51.3)	2.0 (15.4)	2.2 (17.1)	1.6 (12.0)	0.6 (4.3)	13.0 (100)
Dec. 8	9.1 (56.9)	0.8 (4.9)	4.9 (30.6)	1.2 (7.6)	0	16.0 (100)

Figure 1 shows the seasonal prevalence of An. sundaicus in 1980 and 1981. The high density of the mosquito was recognized at the same period in the both years: An. sundaicus started to increase in April or May and reached a peak in June. After that period, the density decreased towards July. In 1981, a rapid decrease of the density occurred about one month after the DDT spray. However, the density started to increase again in September and attained to a high density on the beginning of December in case of outdoor collection.

Table 3 shows the ratio of the densities of An. sundaicus of the outdoor and the indoor collection. The results indicate that higher values were usually obtained after the DDT spray suggesting the avoidance of the mosquitos from entering houses and that An. sundaicus could feed on man mainly outdoors even after the DDT spray.

(2) Susceptibility of An. sundaicus to DDT

Susceptibility to DDT was examined for adult females of An. sundaicus collected in the field before the spray. The WHO method was adopted for this purpose. Number of knocked down adults was observed after the exposure for 1h to the filter paper impregnated with a given concentration of DDT and mortality rate was measured one day after the exposure. Table 4 shows that both the knock down rate and the mortality rate are very high in the lowest concentration of DDT, suggesting An. sundaicus is susceptible to DDT.

(3) Duration of the Residual Effect of the Sprayed DDT

Bioassay was performed using An. sundaicus to determine the duration of the efficacy of DDT sprayed on the walls of village houses in Perupuk. Females of An. sundaicus were forced to contact with the sprayed wall for 1h, then the knock down rate and the mortality rate one day after were recorded. The tests were done from June soon after the spray to November. The results are summarized in Table 5, which shows the efficacy of DDT sprayed on walls has remained at least 6 months after the spray since both the knock down rate and the mortality rate were enough high even in November.

(4) Seasonal Change in the Parous Rate of An. sundaicus

Parous rate of An. sundaicus was calculated every month based on the results of the dissection of individual mosquitos under a microscope (Table 6).

The table shows that the rate was around 30% in the most months except February, March and September. Therefore, An. sundaicus succeeded to feed and furthermore oviposited even if DDT was sprayed.

Figure 2 shows the seasonal change in the malaria parasite rate in the human population in Perupuk. No clear correlation could be obtained between the malaria parasite rate and the population density or the parous rate of An. sundaicus in 1981. The malaria parasite rate decreased slightly after the DDT spray but increased again in September.

(5) Conclusion

Susceptibility test revealed that An. sundaicus is highly susceptible to DDT. Moreover, the residual effect of DDT remained 6 months after the spray. The rapid decrease of the density of An. sundaicus in July 1981 seemed to be the effect of DDT sprayed to the village houses. However, the outdoor collections suggested that An. sundaicus succeeded to feed on man mainly outdoors after the spray. The parous rates also indicated that An. sundaicus could oviposit during that period. Consequently, the population density of An. sundaicus increased again in September 1981. The malaria cases did not decrease so much as expected from the decline in the density of An. sundaicus after DDT spray.

A conclusion from the present one year observation is that the DDT spray could not control the malaria vector in the present study area and more suitable control measures should be searched.

(Yoshiaki Karoji: 1981. Jan. 15 ~ 1982. Jan. 14)

Figure 1 Seasonal Prevalence of Anopheles sundaicus Caught by Man-Biting Collection at Lorong II in Village Perupuk

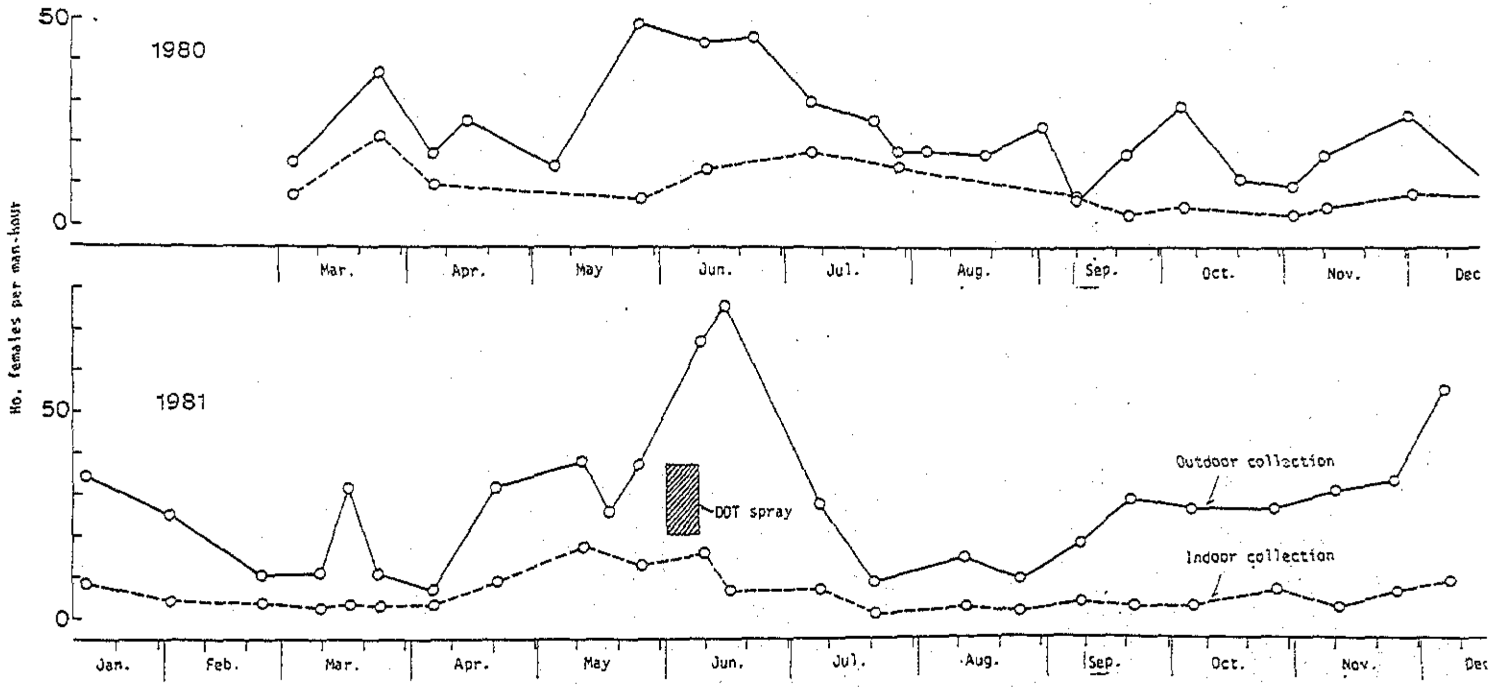


Table 3 Relative Ratio of Females of *Anopheles sundaicus* Caught Outdoors to Those Caught Indoors

1980

Date of collection	I
Mar. 4	2.1
Mar. 25	1.7
Apr. 7	1.8
May 27	7.8
Jun. 12	3.2
Jul. 8	1.7
Jul. 29	1.3
Sep. 10	0.9
Sep. 23	5.9
Oct. 7	5.9
Nov. 3	3.5
Nov. 11	3.7
Dec. 2	3.5
Dec. 22	1.2

1981

Date of collection	I
Jan. 13	4.1
Feb. 2	6.0
Feb. 24	2.7
Mar. 10	4.2
Mar. 17	9.0
Mar. 24	3.8
Apr. 6	2.2
Apr. 21	3.7
May 12	2.2
May 26	2.9
Jun. 10	4.3
Jun. 16	12.2
Jul. 21	10.7
Aug. 12	6.1
Aug. 25	8.5
Sep. 9	4.9
Sep. 22	10.8
Oct. 7	8.8
Oct. 27	3.9
Nov. 11	10.4
Nov. 25	5.1
Dec. 8	6.2

$$I = \frac{\text{No. collected outdoors}}{\text{No. collected indoors}}$$

Table 4 Susceptibility of Adult Females of *Anopheles sundaicus* to the Several Concentration of DDT by Using the Filter Paper method (June, 1981)

Concentration of DDT	No. mosquitoes treated	No. knocked down after 1 h	No. died after 24 hr
4 % (WHO test paper)	63	63	63
4 %	70	70	70
Control	49	0	0
1 %	51	51	51
0.25 %	41	36	41
Control	21	0	0
0.1 %	74	74	74
0.05 %	64	60	64
Control	40	0	3

Table 5 Results of the Bioassay Tests for Checking the Duration of the Effect of DDT Sprayed on the Wall of a Village House in Perupuk by Using Adult Females of *Anopheles sundaicus*

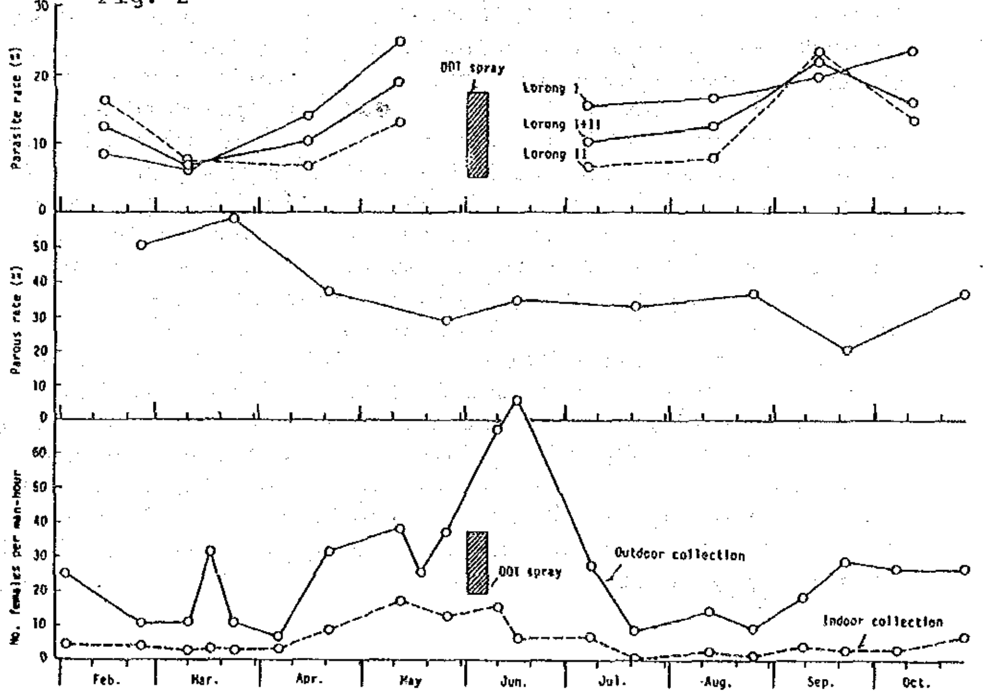
Date of treatment	No. mosquitoes used	No. knocked down after 1 h	No. died after 24 hr
June 10, 1981			
Treated	149	149	149
Control	126	0	6
July 8, 1981			
Treated	120	120	120
Control	25	0	1
August 12, 1981			
Treated	88	88	88
Control	48	0	7
October 7, 1981			
Treated	129	129	129
Control	90	0	4
November 25, 1981			
Treated	157	145	156
Control	112	0	3

Table 6 Perous Rates of <u>Anopheles</u> <u>sundaicus</u> Caught by Man-Biting Collection at Lorong II in Village Perupuk

Date of collection	Site of collection	Percentage of parous females 18:30-20:50	21:00-22:50	Subtotal	Total
Feb. 24	Outdoor	45.2 (42)	53.1 (32)	48.7 (74)	50.5(101)
	Indoor	47.6 (21)	83 (6)	55.6 (27)	
Mar. 24	Outdoor	40.0 (25)	66.7 (39)	56.3 (64)	58.3 (72)
	Indoor	67 (3)	80 (5)	75 (8)	
Apr. 21	Outdoor	29.0 (69)	39.4 (33)	32.4(102)	37.3(142)
	Indoor	36.8 (19)	61.9 (21)	50.0 (40)	
May 26	Outdoor	23.7 (76)	30.3 (76)	27.0(152)	28.5(225)
	Indoor	40.8 (49)	16.7 (24)	32.9 (73)	
Jun. 16	Outdoor	36.3(124)	36.8 (95)	36.5(219)	34.9(269)
	Indoor	29.3 (41)	22 (9)	28.0 (50)	
Jul. 21	Outdoor	23.3 (30)	42.4 (33)	33.3 (63)	32.9 (70)
	Indoor	0 (5)	100 (2)	29 (7)	
Aug. 25	Outdoor	23.4 (47)	54.5 (33)	36.3 (80)	36.7 (90)
	Indoor	25 (8)	100 (2)	40 (10)	
Sep. 22	Outdoor	15.1 (73)	27.4 (62)	20.7(135)	20.1(154)
	Indoor	16.7 (12)	14 (7)	15.8 (19)	
Oct. 27	Outdoor	45.9 (37)	28.9 (38)	37.3 (75)	36.8(125)
	Indoor	25.0 (28)	50.0 (22)	36.0 (50)	
Nov. 25	Outdoor	33.3 (24)	45.5 (66)	42.2 (90)	36.9(149)
	Indoor	24.2 (33)	34.6 (26)	28.8 (59)	

Numbers in parentheses are the numbers of mosquitoes dissected.

Fig. 2



VI. EPIDEMIOLOGICAL STUDIES ON MALARIA IN THE PROJECT AREA

To obtain exact information on the malaria infestation in the project area and to look for more proper control methods, the epidemiological survey was performed.

The six villages (desa) in three subdistricts (kecamatan) were selected for the survey. Desa Perupuk, one of the six villages, was selected for the special study to monitor the malaria epidemics in relation to the entomological, ecological and parasitological study. To detect malaria epidemics, blood and spleen examinations were carried out for children aged 0 to 7 years.

The blood and spleen examination showed that malaria positive cases were detected in the four villages located along the seashore but no case was found in the two villages located apart from the seashore (Fig. 1). The distribution of malaria cases was corresponding to the distribution of Anopheles sundaicus. When the distribution of malaria was examined in detail, all malaria cases were found only at one lorong (subvillage) in desa Medang, and mostly also at one lorong in desa Guntung (Figs. 2 and 3). In desa Perupuk, the malaria endemic area was restricted to lorong I, II, III, IV, and V (Fig. 4). These lorongs were located within 2 km from the seashore. Therefore, the malaria endemic areas distributed patchly along the seashore were smaller than a village. The distribution of malaria cases in desa Perupuk was also corresponding to the distribution of An. sundaicus (see Section IV, Ecology of Malaria Vector). The routine survey at lorong I and II in desa Perupuk showed that the rate of malaria positive cases rapidly increased from June and reached a peak in August, and thereafter sharply declined until January (Fig. 5). This meant that malaria transmission was active from May to July but inactive from September to December. The concentration of parasites in blood for all malaria positive cases were plotted in Fig. 6 to differentiate new infections (acute case) from old ones (chronic case), based on the idea that new infection generally showed higher parasitaemia than old. This analysis confirmed that the active malaria transmission occurred in the dry season which started around January and ended June or July. This result accorded with the finding in the entomological study that the density and longivity of An. sundaicus became a maximum from May to July, and declined in the rainy season.

Figure 1 Comparison of Malaria Parasite Rate Among Six Villages

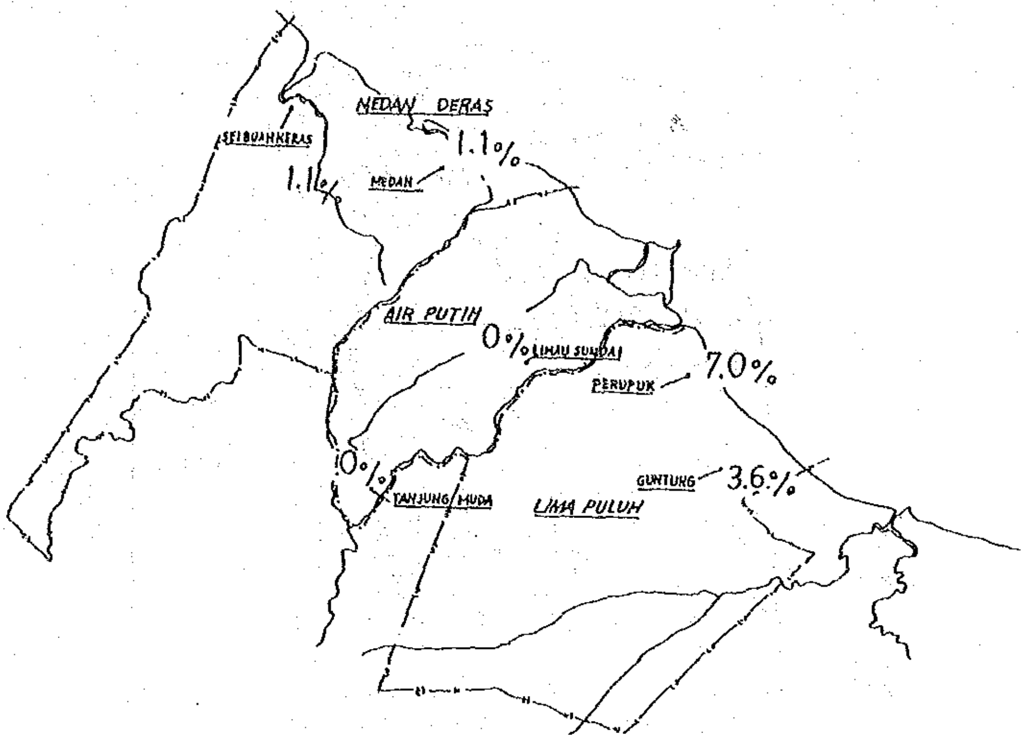
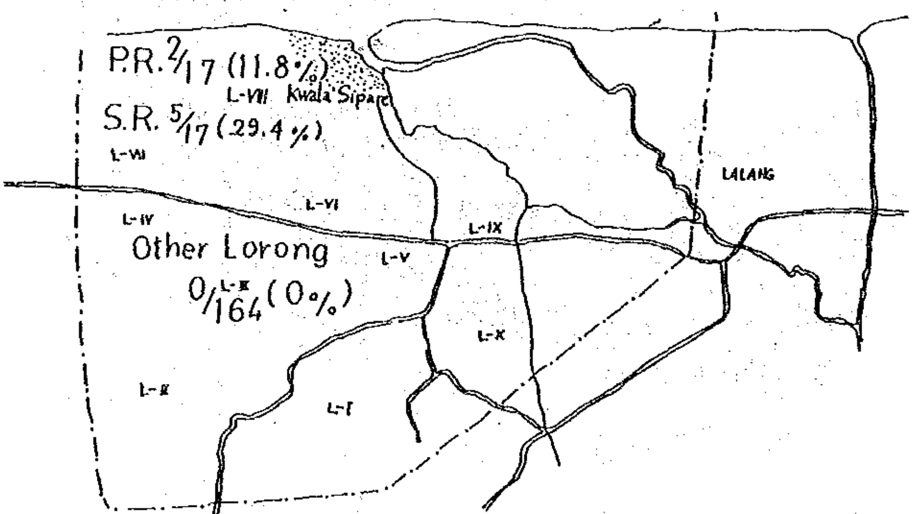
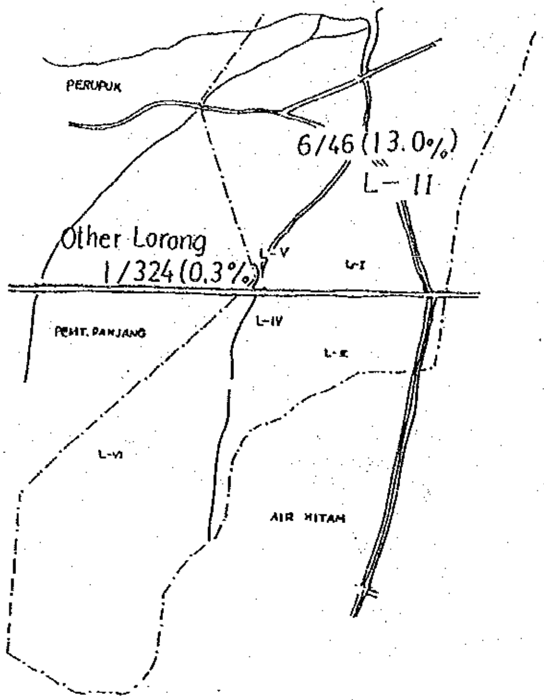


Figure 2 Distribution of Malaria Cases in Desa Medan



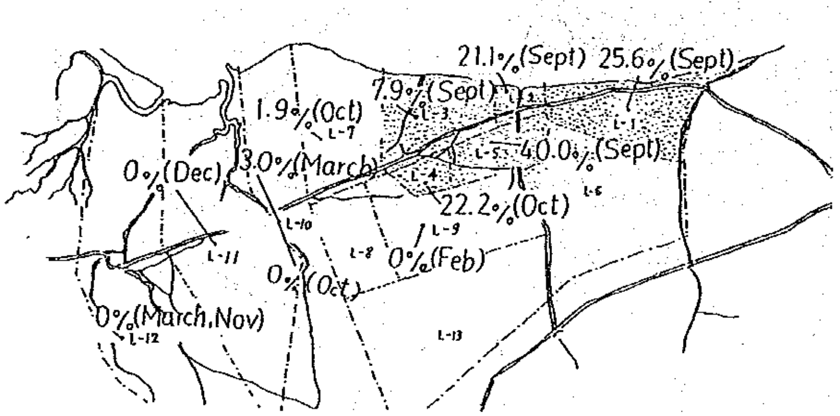
P.R.: Parasite rate
S.R.: Spleen rate
L : Lorong

Figure 3 Distribution of Malaria Positive Cases in Desa Guntung



L : Lorong

Figure 4 Comparison of Malaria Parasite Rate Among Subvillages (Lorong) in Desa Perupuk



L: Lorong

Figure 5 Monthly Fluctuation of Malaria Parasite Rate at Lorong One and Two in Desa Perupuk

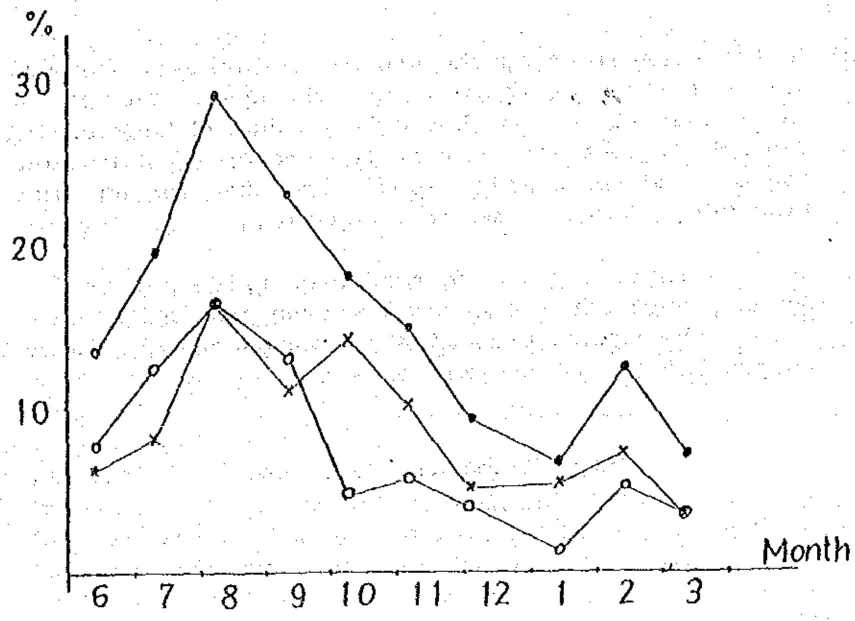
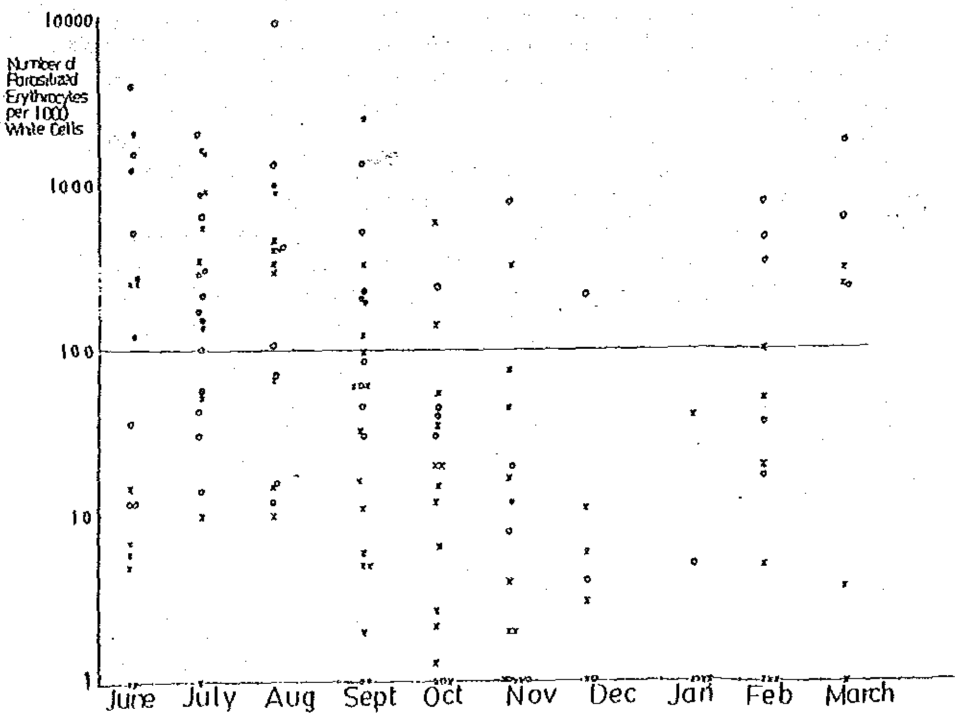


Figure 6 Differentiation of Malaria Cases According to Parasite Concentration



According to these results, the following points should be taken into consideration in the present malaria control activity.

a) In the coastal area, the endemic malaria may have the same character as shown in desa Perupuk. Therefore, the malariometric survey should be conducted between July and September, just after or at the end of transmission season, and the samples should be taken lorong wise to find out a focus of malaria endemic.

b) House spraying should be conducted twice a year in January just after the rainy season and in May just before the active transmission season and should be done thoroughly to the endemic area only.

(Koji Kanbara: 1980. Feb. 1 ~ 1981. Mar. 25)

VII. EPIDEMIOLOGICAL STUDIES IN A PILOT STUDY AREA, PERUPUK

The results of malariometric survey in the pilot village, Perupuk from April to August, 1981 are shown in Table 1, 2, 3 and 4. A total of 1,043 blood specimens was collected and examined of which 86 malaria cases were detected. So, rough parasite rate (p.r.) or laboratory p.r. is 8.2%. Among these positive cases, 60 cases were *P. falciparum* malaria and another 26 *P. vivax* malaria.

As described in the previous section, one of the characters of malaria in the project area is the focalizing of malarious areas even in one village. So the mapping of malarious areas in certain village and the decision of the priority zone of insecticide spraying should be done prior to the attack actions.

Average p.r. is not always reflected the endemicity of a certain area. The spleen rate (s.r.) is generally used for the classification of endemicity. It seems to be difficult to find exactly the cases with class I splenomegaly in field work. Because average s.r. in Perupuk is 5.1% according to previous survey, this pilot village is the hypoendemic malaria zone.

Therefore the insecticide spraying should be carried out in April and December for covering effectively the whold transmission season. The reason why the second spraying should be carried out in December is that the small transmission probably persists at the end of the rainy season. Average p.r. through year at Lorong I and II was 14.8%. It was obvious that the seasonal rise of p.r. over average one occurred once a year in the pilot village, which was ofcourse resulted by the seasonal prevalence of the transmission. The seasonal rise of p.r. was remarkable at Lorong I than at Lorong II.

Table 1 Result of Preliminary Malariometric Regular Survey At Perupuk (April, 1981)

I. Number of cases examined and malaria cases

Age & Sex / Lorong	0 - 7			8 - 9			10 -			Total		
	M	F	T	M	F	T	M	F	T	M	F	T
I	34	23	f5 V3 57	0	0	0	4	1	5	38	24	62
II	31	28	f4 59	1	0	1	1	1	2	33	29	62
III	25	39	V1 65	0	1	1	7	4	11	33	44	77
IV	10	11	f1 V3 21	0	0	0	1	3	f1 4	11	14	25
V	16	30	f1 46	0	0	0	3	6	9	19	36	55
VIII	39	23	62	1	1	2	3	3	6	43	27	70
XIII	23	8	31	1	4	5	10	11	21	34	23	57
Others	3	3	6	0	0	0	2	1	3	5	4	9
Total	182	165	347	3	6	9	31	30	61	216	201	417

f: Number of Pf malaria cases
V: Number of PV malaria cases

II. Parasite rate in children aged 0 - 7 years

Lorong / Species	I	II	I + II	III	IV	V
Pf	5/57 8.8%	4/59 6.8%	9/116 7.7%	0/65 -	1/21 4.8%	1/46 2.2%
PV	3/57 5.2%	0/59 -	3/116 2.6%	1/65 1.5%	3/21 14.3%	0/46 -
Total	8/57 14.0%	4/59 6.8%	12/116 10.3%	1/65 1.5%	4/21 19.1%	1/46 2.2%

Table 2 Result of Preliminary Malariometric Regular Survey at Perupuk and Post Spraying Malariometric Survey at Guntung (May, 1981)

I. Number of cases examined and malaria positive cases

Desa. / Lorong \ Age & Sex		0 - 7			8 - 9			10 -			Total		
		M	F	T	M	F	T	M	F	T	M	F	T
Perupuk	I	26	22	f7 v5 48	0	1	f1 1	4	6	f2 10	30	29	59
	II	20	26	f3 v3 46	5	4	9	7	5	f1 12	32	35	67
	Others	13	6	19	0	0	0	1	2	3	14	8	22
Guntung	I	11	8	19	1	6	7	2	2	f1 4	14	16	30
	II	12	25	v1 37	2	3	5	5	11	f1 16	19	39	58
	Others	1	5	6	3	3	6	2	0	2	6	8	14
Total		83	92	175	11	17	28	21	26	47	115	135	250

f: Number of Pf malaria cases
V: Number of PV malaria cases

II. Parasite rate in children aged 0 - 7 years

Species \ Lorong	I/Perupuk	II/Perupuk	I+II/Perupuk	II/Guntung
Pf	7/48 14.6%	3/46 6.5%	10/94 10.6%	0/37 -
PV	5/48 10.4%	3/46 6.5%	8/94 8.5%	1/37 2.7%
Total	12/48 25.0%	6/46 13.0%	18/94 19.1%	1/37 2.7%

Table 3 Result of Post Spraying Malariometric Survey at Perupuk (July, 1981)

I. Number of cases examined and malaria cases

Age & Sex / Lorong	0 - 7			8 - 9			10 -			Total		
	M	F	T	M	F	T	M	F	T	M	F	T
I	17	21	f5 v1 38	2	4	6	11	12	f1 23	37	30	f6 v1 67
II	27	33	f2 v2 60	8	2	v1 10	8	5	f1 13	43	40	f3 v3 83
	44	54	f7 v3 98	10	6	v1 16	19	17	f2 36	80	70	f9 v4 150

f: Number of Pf malaria cases
v: Number of Pv malaria cases

II. Parasite rate in children aged 0 - 7 years

Lorong / Species	I	II	I + II
Pf	5/38 13.2%	2/60 3.3%	7/98 7.1%
Pv	1/38 2.6%	2/60 3.3%	3/98 3.1%
Total	6/38 15.6%	4/60 6.6%	10/98 10.2%

* P < 0.01) Comparison with data in
** P < 0.1) July 1980

Table 4 Result of Post Spraying Malariometric Survey at Perupuk (August, 1981)

I. Number of cases examined and malaria cases

Age & Sex / Lorong	0 - 7			8 - 9			10 -			Total		
	M	F	T	M	F	T	M	F	T	M	F	T
I	38	33	71 f11 v1	0	0	0	0	0	0	38	33	71
II	32	32	64 f3 v2	0	0	0	1	0	1	33	32	65
III	24	31	55 f2 v2	0	0	0	1	0	1	25	31	56
IV	13	15	28 f1 v1	0	0	0	0	0	0	13	15	28
V	22	20	42 f5	0	0	0	0	0	0	22	20	42
VII	14	8	22 v1	0	0	0	1	0	1	15	8	23
VIII	14	16	30	1	0	1	1	0	1	16	16	32
Others	4	7	11 f3*	0	0	0	0	0	0	4	7	11
Total	161	162	323 f25 v7	1	0	1	4	0	4	166	162	328

f: Number of Pf malaria cases
v: Number of Pv malaria cases
*: 1 case .. Lorong VI,
2 cases .. Lorong XIII

II. Parasite rate in children aged 0 - 7 years

Lorong	I	II	I + II	III	IV	V	VII
Pf	11/71 15.5%	3/64 4.7%	14/135 10.4%	2/55 3.6%	1/28 3.57%	5/42 11.9%	0.22 -
PV	1/71 1.4%	2/64 3.1%	3/135 2.2%	2/55 3.6%	1/28 3.67%	0/42 -	1/22 4.3%
Total	12/71 16.9%	5/64 7.8%	17/135 12.6%	4/55 7.2%	2/28 7.14%	5/42 11.9%	1/22 4.3%

For thinking of Malaria control program, it is convenient to decide the stability of malaria after Macdonald (1957).

$$\text{Index of stability} = \frac{a}{-\log e\ P}$$

a : The average number of man bitten by one mosquito in one day

p.: The probability of a mosquito surviving through one day.

Over 2.5	Stable malaria
0.5 ∿ 2.5	Intermediate type
Below 0.5	Unstable malaria

The index of stability in this village was calculated to be 1.18 from Ikemoto's data. This figure indicated that the malaria in this village was the intermediate type and amenability to control seemed not to be difficult.

Residual DDT spraying of 2 g/m^2, which was WHO standard method, was carried out to 1,432 houses out of 1,674 in the whole pilot village by our malaria control team of the provincial health service of North Sumatra. The coverage rate was 85.5% (Table 5). The worst coverage rate (62.2%) was that of Lorong I which was the most dangerous malaria endemic area in Perupuk. According to the results of house to house visit canvassing at Lorong I, out of 23 houses, only 14 were sprayed (60.9%). And 36.8% of these families did not know the malaria, and among families knowing malaria, 66.7% did not know it's infections route, 67% did not know they are living in a highly malarious area. This result suggests how the health education is important for malaria control.

Table 5 DDT House Spraying at Perupuk (June, 1981)

Lorong	Total Number of Houses	Houses Sprayed		Lorong	Total Number of Houses	Houses Sprayed	
		Number	%			Number	%
I	143	89	62.2	VIII	114	100	87.7
II	187	142	75.9	IX	118	105	89.0
III	82	53	64.6	X	131	120	91.6
IV	45	45	100	XI	107	93	86.9
V	73	49	67.1	XII	200	200	100
VI	143	121	81.3	XIII	178	175	98.3
VII	148	140	94.6	Total	1,674	1,432	85.5

It was difficult to determine infant parasite rate (and/or transmission index) at the pilot village because of small sample size. For example, infants under 1 year of age at *Lorong I and II examined from April to August* were total 23 children, average 5.6 children/month only, including no malaria cases. According to house to house visit canvassing at Lorong I, 17 families out of 19 (89.5%) had mosquito nets and their infants were protected against malaria by using mosquito nets.

Instead of infant parasite rate, the p.r. of children aged 1 year in April, May, July and August were 3/15 (20%), 1/8 (12.5%), 1/5 (20%) and 1/5 (20%), respectively. Although the number of cases examined was not enough, those p.r. were almost constant and did not change even in the post spraying period. If those were related with the transmission index, it was suggested that the transmission still continued at that time.

For the another criteria, the parasites per 1,000 white blood cells in thick smear were counted and 120 or more parasitemia was regarded as heavy infection. It is recommended to use this method for MCP because of this simplicity. According to the previous data obtained by Dr. Kambara, the heavy infection cases were 32 out of 56 (57.1%) from June to August, while 6 out of 42 (14.3%) from October to December in 1980. These are showing the seasonal variation as same as the transmission period. In

1981 the heavy infection cases detected by the post spraying survey were 6 out 29 (20.7%, as same as percents of the p.r. obtained from one year old children group).

As it has been noticed that there is a great discrepancy between the clinical malaria cases and the parasite rates, the system to discover exactly the genuine malaria from clinical malaria must be established.

As the test case of this method, the blood specimens were collected from the clinical malaria at Perupuk BPU during June and July, 1981. Four cases (2 P.f., 2 p.v.) out of 28 were discovered so that the correct malaria diagnosis rate was 14.3%.

The target point of MCP in this project area planned by Indonesian Government is to reduce the p.r. from 8.26% to 1.06%. If the results of previous malariometric survey in the project area are correct, this target point has already been achieved. Since the malaria in this area is thought to be the intermittent type and hypoendemic as mentioned above, it is not surprised to achieve such a level within three years through the regular DDT spray. However, malaria in this area has remained focally and very high-endemically.

PRELIMINARY SURVEYS ON INLAND MALARIA AND THE MALARIA OF THE WEST COASTAL AREA

The malaria distribution in North Sumatra had been surveyed by the MCP team of the provincial health service of North Sumatra. Main malarious area in North Sumatra is limited to the coastal area. And so called inland malaria showing lower p.r. is existing focally in some districts. districts.

The survey on the inland malaria was carried out in village Air Songsongan, Bandar Pulau in June, 1981. Although malaria parasites had been confirmed in the blood specimens obtained from this area, no malaria positive case was detected on this occasion. The spleen rate was 11.6%.

Hajoran village, Sibolga in the West coast region of North Sumatra was surveyed for the malarial study. Entomological survey of last November had unfortunatly failed to collect adult vectors because of heavy rainfall. Then malariometric and entomological survey was carried out in the same village in July, 1981. The results of malariometric survey (s.r. 31.7%, p.r. 23.5%) in this village was almost same as those (s.r. 52.8%, p.r. 34.8%) obtained in 1980 (Table 6). While the p.r. (2.8%) and the s.r. (6.9%) in the neighboring village Pandan, located beyond two capes from Hajoran, were significantly lower in comparison with those in Hajoran (P = 0.01, p = 0.05, respectively).

(Hiroyuki Amano: 1981. Mar. 14 ~ 1981. Sep. 13)

Table 6 Result of Some Spot Malariometric Survey (July, 1981)

I. Hajoran, Sibolga (28 July 1981)

a) Number of cases examined and malaria cases

Sex \ Age	0 - 1	2 - 7	8 - 9	10	Total
Male	5	21	25	1	52
Female	8	17	28	0	53
Total	13 f1, v1 s2	38 f7, v3 s15	53 f3, v3 s16	1	105 f11, v8 s33

f: Number of Pf malaria cases
v: Number of Pv malaria cases
s: Number of splenomegaly

b) Parasite rate (0 - 7 y.o) 12/ 51 (23.5%)

c) Spleen rate (0 - 9 y.o) 33/104 (31.7%)

II. Pandan, Sibolga (29 July, 1981)

a) Number of cases examined and malaria cases

Sex \ Age	0 - 1	2 - 7	8 - 9	10	Total
Male	2	13	10	0	25
Female	5	16	12	0	33
Total	7	29 f1, s3	22 s1	0	58

f: Number of Pf malaria cases
v: Number of Pv malaria cases
s: Number of splenomegaly

b) Parasite rate (0 - 7 y.o) 1/36 (2.8%)

c) Spleen rate (0 - 9 y.o) 4/58 (6.0%)

VIII. ASSESSMENT ON THE MALARIA CONTROL IN A PILOT STUDY AREA IN 1982

Since DDT spray in Perupuk conducted in June 1981 was not successful in controlling the *An. sundaicus* population and the malaria transmission, the spray was repeated in December of the same year. The result was contrary to the expectations again. The man-biting density of the vector rather increased in the following months. However it was difficult to conclude definitely that DDT spray was totally ineffective, because the coverage of the spray was incomplete again, say less than 70%. It was also not overlooked that the refusal of the residual spraying of DDT was common in the Block I and II where the highest number of cases of malaria was recorded. Therefore, the 3rd trial with the same method was carried out in late May 1982 with a special care on the higher coverage. To accomplish this, the health education using movie films on malaria etc. was made actively to the villagers and the subsequent DDT residual spray could cover nearly 90% of the houses. Thus, a definite conclusion on the effectiveness of DDT indoor residual spray for control of *An. sundaicus* will be obtained by the end of 1982.

However, it is very unlikely to prove the effectiveness of the DDT spray, because it has been found that *An. sundaicus* in this village is exophilic*. Therefore one must consider another control methods against *An. sundaicus* in this village. Since the larval habitats were restricted in numbers and size, particularly, in the dry season when the malaria cases increased, the Japanese experts (Karoji & Imai) considered larval control might be practical and also effective. Though the actual control methods will be decided later, the basic data on the breeding sites of larvae of *An. sundaicus* have been collected by C. Imai and the Indonesian counterparts.

(*) This means that adult mosquitos feed mostly outdoors but even those feeding indoors do not rest on the wall of rooms where DDT had been sprayed.

(Masayuki Yasuno: 1978. Feb. 25 ~ 1978. Mar. 18, 1979. Feb. 23 ~ 1979. Mar. 15, 1980. Nov. 3 ~ 1980. Nov. 22)

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2. Communicable Diseases and Parasite Control

I. GENERAL REMARK

Communicable diseases are the major obstacle to the health of people in North Sumatra. Without controlling these endemic or sometimes epidemic communicable diseases, primary health care would not attain the target. Among so many communicable diseases possible to occur, we were lead to conclude by reading the previous records that malaria and enteric (diarrheal) diseases were the disease of primary importance in the project area. These two category of diseases were most prevalent and so great in number and also threatening diseases since many non-immune people were to be introduced into the area at that time. Considering the previous examples in the history, prevention of the outbreak of these serious diseases was the first task to do in the area for this project. (Table 1, 2)

Before taking up individual diseases to discuss, one point which should be stressed is the necessity of accurate health statistics. Reporting system seemed to have been prepared in North Sumatra and functioned to a certain degree but still much has been waited to have scientifically reliable base line data especially considering differences in geographical areas. At the initial stage, in order to understand and record the health situation in Asahan regency, North Sumatra, 6 community villages were selected each two representing three geographical strata, namely coastal area, plain area and mountainous area. Name of the villages were Sei Buah-Keras and Medan in Medan Deras, Limau Sundai and Tanjung Muda in Air Putih, and Perupuk and Guntung in Lima Puluh. Although some factors might be taken into consideration in every occasion, every possible effort should be made to secure scientifically sound sampling methods.

Walsh and Warren (1979) wrote a special article in New England Journal of Medicine (301: 967-974, 1979) entitled "Selective primary health care, An interim strategy for disease control in developing countries". In it they listed a table classifying the infectious diseases into three groups according to the priorities for disease control in the developing countries based on prevalences, mortality, morbidity and feasibility of control. They propose the following diseases to be included in the high priority group: diarrheal diseases, malaria, measle, whooping cough, schistosomiasis and neonatal tetanus. Although there would be some points to be discussed in their article these are

Table 1 Health Statistics in Asahan Regency in 1973

Number	Disease	Number of patients
1	Malaria	6,770
2	Influenza	3,848
3	Ulcer	3,528
4	Tuberculosis	3,497
5	Diarrhoea	2,761
6	Bronchitis	2,386
7	Anemia	2,267
8	Eye diseases	1,304
9	Dysentery	1,275
10	Respiratory diseases	1,072
11	Parasitosis	1,000
12	Avitaminosis	705
13	Hypertension	249
14	Heart diseases	201
15	Beriberi	169
16	Smallpox	158
17	Gonorrhoea	105
18	Malnutrition	45
19	Tetanus	19
20	Others	2,486

(Report of survey mission, Dr. T. Ohiso et al., 1977)

Table 2 Major Communicable Diseases in Asahan Regency

	1971	1972	1973
Malaria	4,662	8,159	15,872
Tuberculosis	1,488	2,123	3,497
Cholera	189	496	271
Filaria	61	183	255
Lepra	98	120	138

useful idea to be taken into consideration. Groups of diseases of medium priority are respiratory infections, poliomyelitis, tuberculosis, onchocerciasis, meningitis, typhoid, hookworm and malnutrition.

Among listed communicable diseases in North Sumatra, some important diseases will be reviewed briefly according to the priority from the standpoint of public health and feasibility of control measures.

Malaria.
Enteric (diarrheal) diseases and parasitic diseases.
Tuberculosis.
(These are treated elsewhere by the experts.)

Smallpox. This has been successfully eradicated by the year 1974. This is a brilliant example of cooperated medical project.

Tetanus. This is an important disease especially for neonates and pregnant women with high fatality rate. Thorough immunization programme would be expected.

Respiratory infectious diseases. This constitutes most common diseases including influenza, bronchitis and others. Effective control measures are not available except vaccination for measles and others.

Meningitis. There seems many cases of this disease occurring in North Sumatra but causative agent has not been well studied in most cases. Detailed investigation would be necessary in future.

Rabies. This is an important serious disease not only for man but also for domestic animals in North Sumatra and so another JICA project had been also settled in Medan aiming mainly at veterinary aspects.

Sexually transmitted diseases. This is also one of worried diseases but the situation has not been well investigated.

Infectious hepatitis. Many foreign people fall victim to this disease and so it is an important one for non-immune foreigners for example Japanese under 30.

Haemorrhagic fever (Dengue). Recently in Southeast Asia much attention has been paid to this disease. The situation in North Sumatra has not been studied well yet.

Filariasis. Malayan filariasis is endemic in coastal areas in North Sumatra. Reported prevalence rates ranged between 5 and 10%. Joesoef and Cross (1978) reported detection of microfilaria in daytime in Asahan regency as a new finding in North Sumatra. This should be confirmed together with determination of the vector mosquitoe species since different genus was listed for different types of periodicity. Control measures should be done at a proper stage after study.

Amebiasis. Statistics tell that this infection was found 6% in North Sumatra and 14% in Aceh. Seroepidemiological study in Sumatra revealed 13% positive rate. Entamoeba coli was found in 26% people and giardiasis was 4%.

Lepra. The situation has not been well investigated. Treatment at home is the present day principle. Segregation is impossible because of religious and financial problems.

Frambesia. This disease has been successfully controled and nearly eradicated by the use of Penicillin in the national plan.

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(Akira Ishii: 1977. Sep. 29 ~ 1977. Oct. 11, 1979. Feb. 5 ~ 1979. Mar. 15, 1981. Dec. 13 ~ 1981. Dec. 29)

II. TIME SCHEDULE OF THE PROJECT

As a technical cooperation project, Asahan health project is not able to support all aspects of health administration of North Sumatra. Considering that it has certain financial and time limits we must concentrate ourselves on some important points efficiently. Time allocation is also an important procedure in carrying out the project. We proposed four phases in time schedule.

Phases:
1. Preparatory phase
2. Examination of the control measures
3. Trial of the measure
4. Evaluation

If we have five years, we can allocate one year for phase 1, two years for phase 2 and 3, one year for phase 4. Phases may be overlapped each other. Targets in individual disease in each phases should be discussed in the project managements.

(Akira Ishii: 1977. Sep. 29 ~ 1977. Oct. 11, 1979. Feb. 5 ~ 1979. Mar. 15, 1981. Dec. 13 ~ 1981. Dec. 29)

III. ENTERIC (DIARRHEAL) DISEASES

(1) Cholera

At the beginning of the project, this disease was very much feared of to outbreak. However, only the name of diarrhoea and vomitting was found in previous health records. Now the disease is correctly diagnosed based on bacteriological examinations in Medan Health Laboratory. Necessary equipments and expertise have been supplied through the project activities. This good situation should be maintained and developed.

In December 1978, a cholera epidemic was outbroken in North Sumatra. Experts of the project were asked to observe the situation and give necessary advice. There was a report of uneasiness among immigrated workers. After reviewing the local situation of epidemic and hygiene several points have been advised by the experts and fortunately the problems were solved successfully.

(Akira Ishii: 1977. Sep. 29 ~ 1977. Oct. 11, 1979. Feb. 5 ~ 1979. Mar. 15, 1981. Dec. 13 ~ 1981. Dec. 29)

(2) Epidemic of Cholera in North Sumatra

Big epidemic of cholera started at Nias island on the 19th March 1978, which was spread to the main area of North Sumatra Province. Total number of clinically suspected cholera cases reached to 23,900 in which 1,110 died by the 30th week 1980. We have collected data on the epidemic at Provincial Health Service of North Sumatra, Regional Health Services of Medan and Asahan, Health Centers of Medang Deras, Indrapura and Lima Puluh in Asahan Regency, Clinics of Porsea and Silaen in Tapanuli Utara Regency and Regional Health Laboratory in Medan and analyzed them statistically to draw the entire figure of the spread and routes of the epidemic.

Figure 1 shows trends in number of clinical cases suspected of cholera in North Sumatra by 4-weekly reports. Number of cases was increased from the beginning of 1978 to reach a peak at the beginning of 1979 followed by decrease to the end of the year and drew another small peak in 1980.

Figures 2 and 3 show trends of the epidemic in each regencies and municipalities of North Sumatra. The figures were arranged in order to the date of onset of the first main epidemic. The first epidemic was found to be transferred along a national highway from Sibolga to Medan after establishment of the epidemic at Sibolga city (Figure 4). The transfer was rather slow and it took about 20 weeks from Nias to Deli Serdang and about 25 weeks from Deli Serdang to Labuhan Batu.

Figure 1 Clinically Reported Cholera Cases in North Sumatra, Indonesia by 4-Weekly Reports

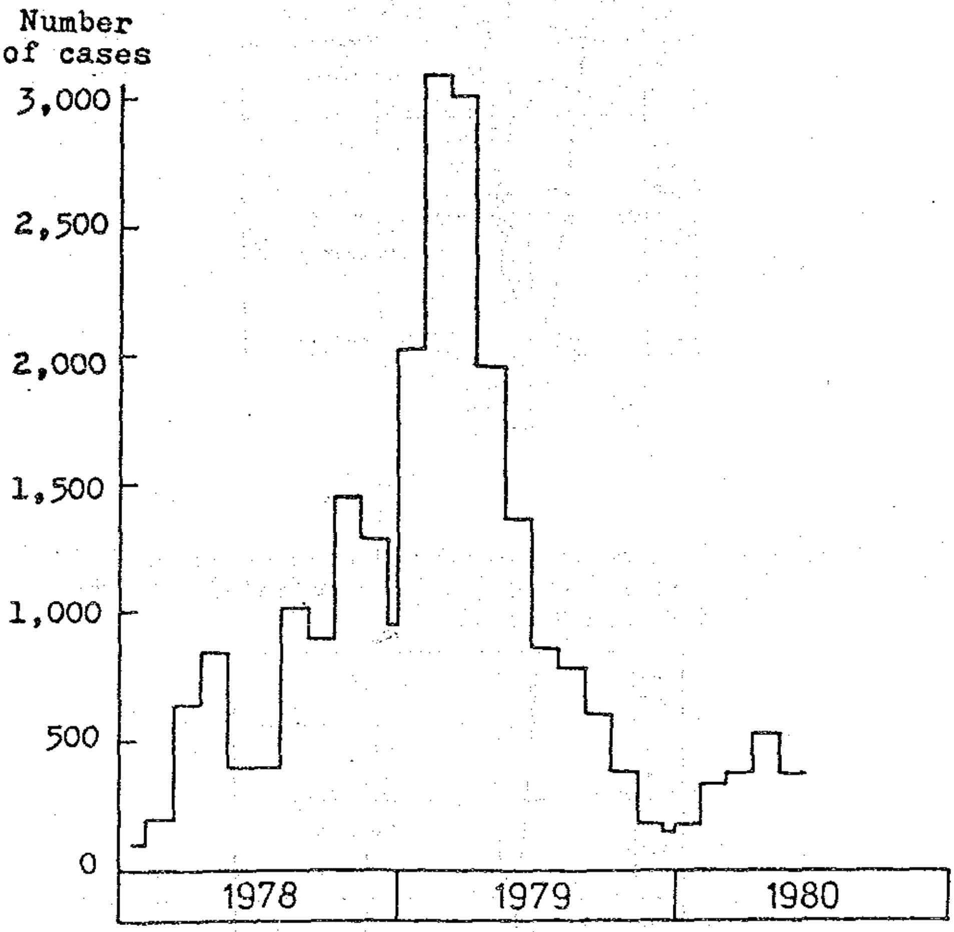


Figure 2 Clinically Reported Cholera Cases in Each Regencies, North Sumatra by 4-Weekly Reports

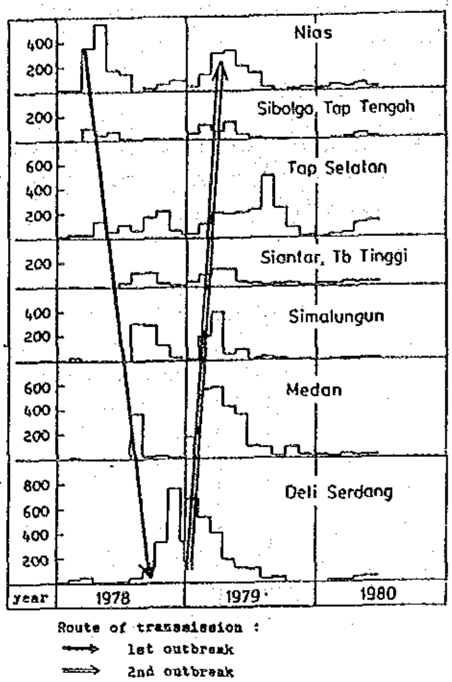
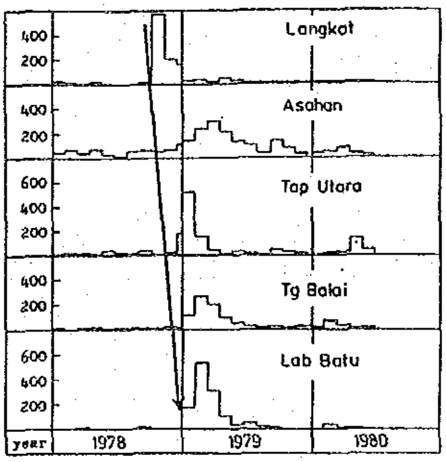


Figure 3 Clinically Reported Cholera Cases in Each Regencies, North Sumatra by 4-Weekly Reports



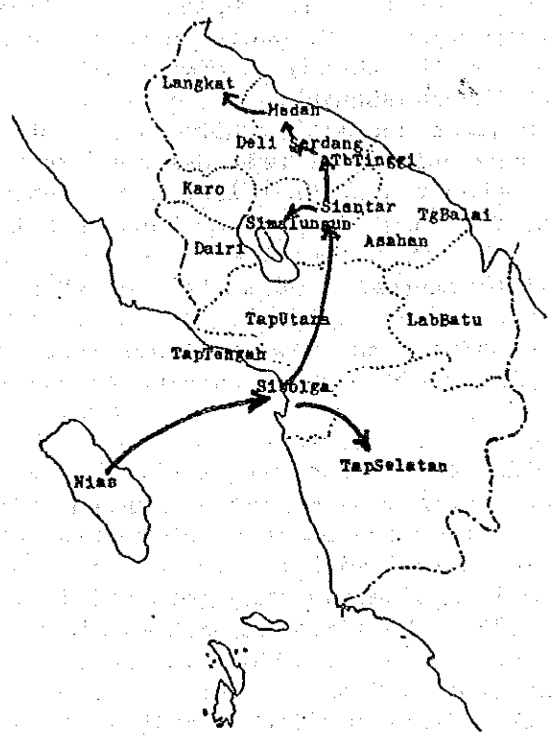


Figure 4 Route of Transmission of the 1st Outbreak of Cholera in North Sumatra, 1978

From the figures, onset of second peak was found to be arranged at a reverse order in 9 regencies and municipalities where the second peak appear, which means that the second epidemic was transferred reversely along the same highway to Sibolga and finally to Nias island where the first epidemic started (Figure 5). The second transfer was also rather slow and it took about 6 weeks from Deli Serdang to Nias.

From bacteriological examinations in Regional Health Laboratory in Medan, only Vibrio cholerae Eltor Ogawa strains were isolated from feces and rectal swab specimens taken from about 7,500 clinically suspected cholera cases along the first transfer from Nias island to Deli Serdang until the first detection of V. cholerae Eltor Inaba strain at Deli Serdang on the 26th of December 1978. After 4 days, second Eltor Inaba strain was detected in the same regency. Since the beginning of 1979, Eltor Inaba strains were detected consecutively at Deli Serdang, Medan, Tapanuli Utara and Asahan regencies followed by Tanjung Balai, Simalungun, Pematang Siantar and Labuhan Batu regencies and municipalities with Ogawa strains. In Nias island, only Inaba strains were detected at the second epidemic. Conclusively, the second epidemic was associated with Inaba strains in addition to Ogawa strains, which resulted the epidemic by only Eltor Inaba strains in Nias island since February 1979.

Cholera epidemic in Medan city started at an area of Belawan port facing Malacca Strait on the 31st week 1978 (Figure 6). After the epidemic at Belawan area ceased, big epidemic started with 2 waves at the central area including main residential and commercial areas since the 37th week 1978. The first wave started on the 37th week and ceased at the end of 1978. The second wave started at the beginning of 1979 and reached to a peak on the 8th week 1980. South 3 districts including hilly area cultivating fruits and vegetables were affected from only sporadic cases. During the epidemic in Medan, dominant agents were Eltor Ogawa strains. Eltor Inaba strains were detected since the first week until the 8th week 1979.

There is an endemic area of cholera, Sukaramai, in the center of Medan. Sporadic cases have been detected in this area consecutively since 1962. Number of cases was highly increased during the course of the big epidemic in this area. However, there is no evidence that the big epidemic was originated from this area.

Figure 7 shows trends of cholera epidemic in the project area of Asahan Regency. The epidemic started at Medang Deras district and transferred to Air Putih district but not to Lima Puluh district. Main waves of the epidemic covered western area of Medang Deras district including Pangkalan Dodek, Sei Buahkeras, Sidomulio, Aek Nauli, Nanasiam and Sei Rakyat and central area of Air Putih district including Pematang Panjang, Sipare-pare, Limau Sundai, Suka Raja and Simodong. Cases were few at plantation areas of rubber and oil palm in Air Putih and Lima Puluh districts during the course of this epidemic, which might reflect the difference of sanitary conditions of these areas.

Figure 8 shows clinical cholera cases in Bagan Asahan, a village facing Malacca Strait in Asahan Regency, where most inhabitants are engaged in fishery and commerce. This village is one of the endemic area of cholera since 1962. The figure shows 2 epidemic waves of cholera in 1972 and 1973. The last epidemic originated from Nias island entered also to this small village in 1979.

Bagan Asahan and Medang Deras are common geographically. Both area cover low wet land located at estuaries of big rivers. These geographical features might support entrance and endemization of enteric diseases as cholera or dysentery with low sanitary conditions.

Figures 9 and 10 show trends of cholera epidemic in Porsea and Silaen in Tapanuli Utara Regency. National highway run in this area. This area is important because the area is closed to a construction site of power station for an aluminium smelter plant, Asahan Project, whose laborers live in this area. Fortunately, the epidemic was decreased with few influence to the power site area.

The big epidemic of cholera was decreased gradually, not from control activities but from etiological nature(s). Thus, repeated onset(s) of big epidemic(s) might not be negligible unless improvement of sanitary conditions. We will expect the effort to improve sanitary conditions.

(Norichika Kumazawa: 1978. Nov. 17 ~ 1980. Nov. 16)

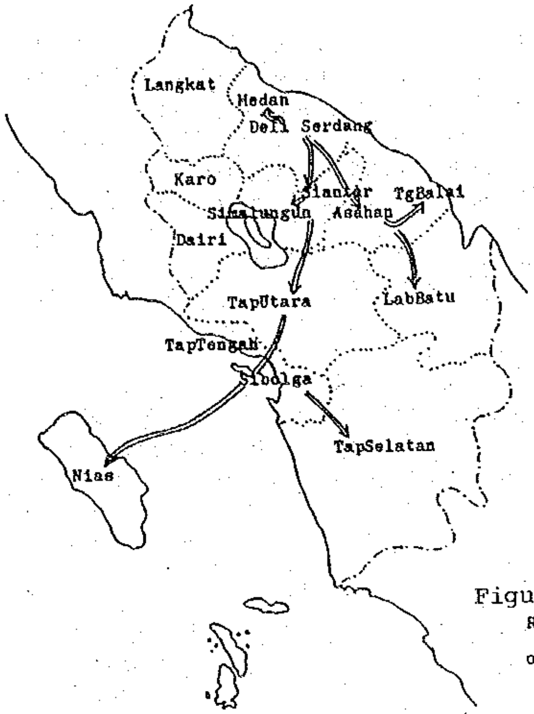


Figure 5
Route of transmission of the 2nd outbreak of cholera in North Sumatra, 1979

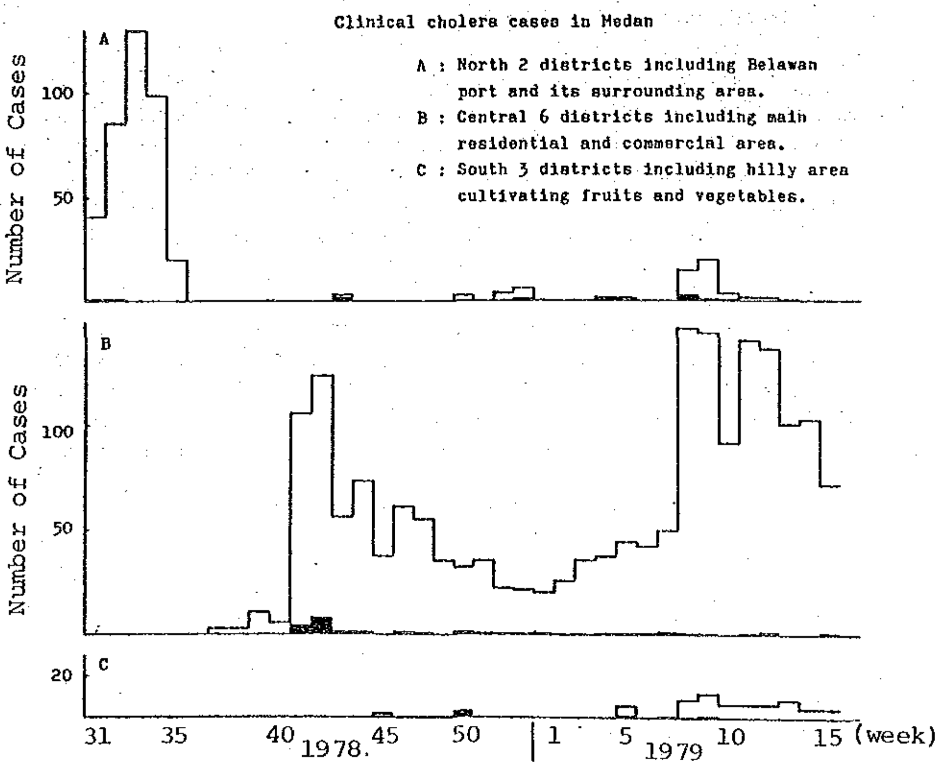


Figure 6 Open and Closed Bars Indicate Numbers of Cases and Deaths Respectively

Figure 7 Clinical Cholera Cases in the Project Area

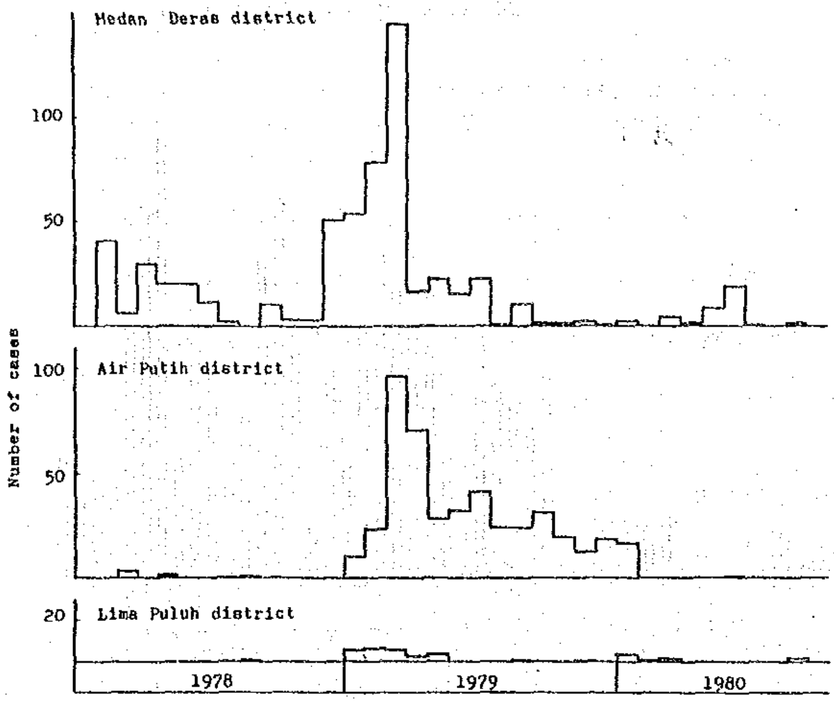


Figure 8 Clinically Suspected Cholera Cases Reported Weekly in Bagan Asahan

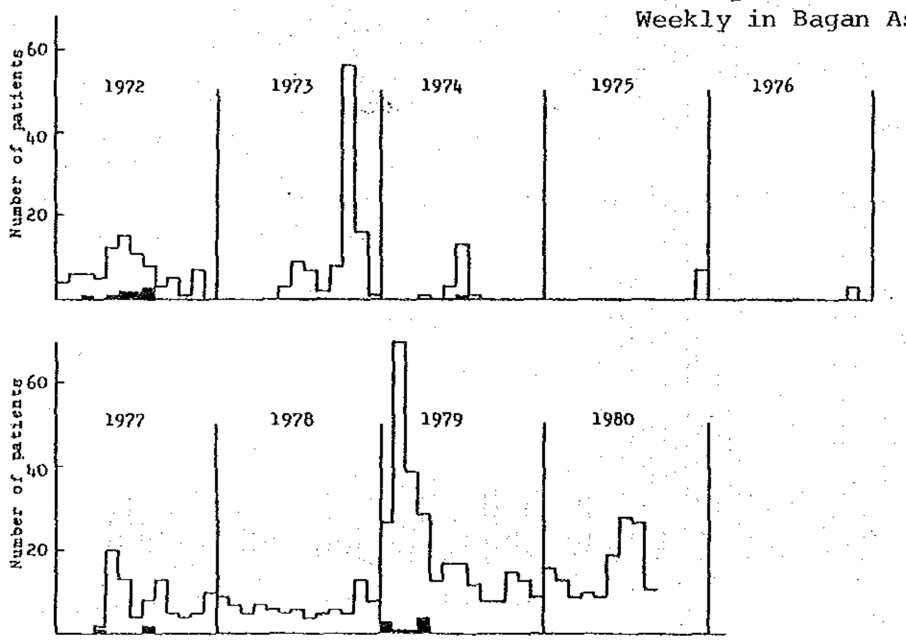
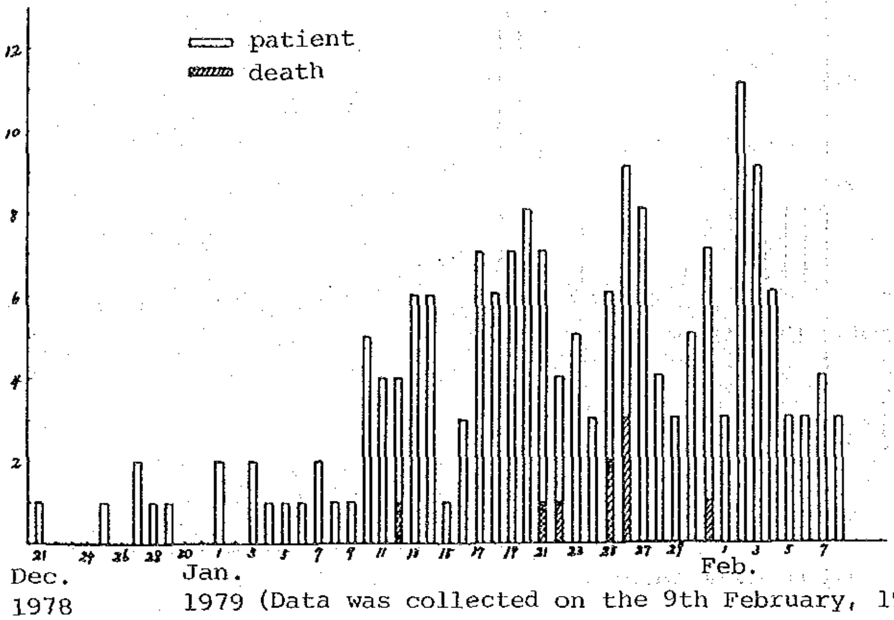
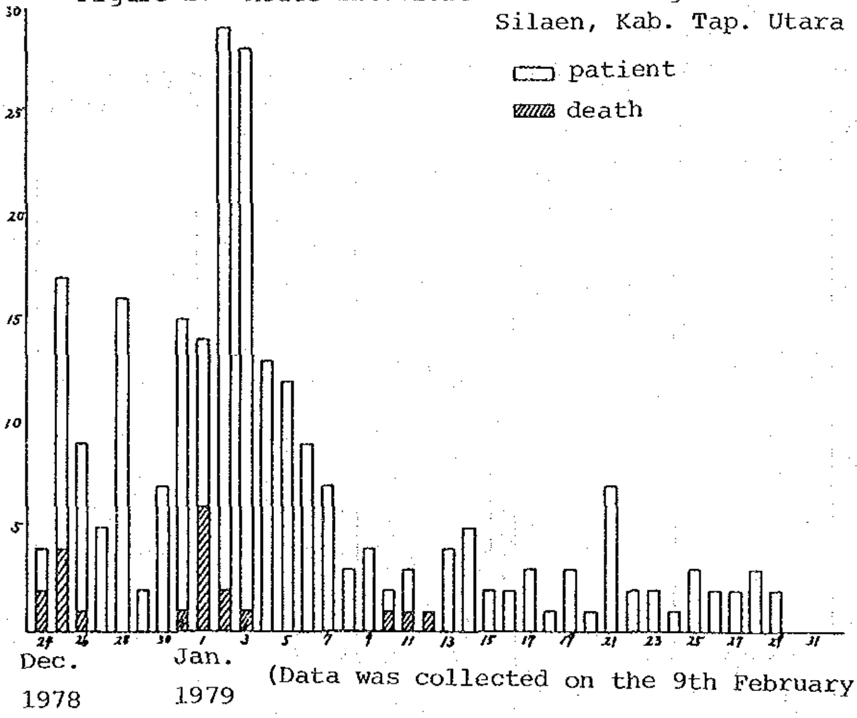


Figure 9 Acute Enteritis with Vomiting Treated at R.S.P. Porsea



(Data was collected on the 9th February, 1979)

Figure 10 Acute Enteritis with Vomiting in Kec. Silaen, Kab. Tap. Utara



(Data was collected on the 9th February, 1979)

(3) Cholera (1981)

① Project area

The project covers 50 villages in three districts of Asahan Regency in North Sumatra Province. Number of population is as follows,

Lima Puluh district is about 61,000 persons

Air Putih district is about 53,000 persons

Medan Deras district is about 25,000 persons

It was decided to select Medan Deras district for the cooperative activity in the investigation of the cholera endemic and the real situation of transmission intra/inter endemic area in connection with the environmental factors or media of transmission. According to the document of cholera morbid cases (including suspects) in various villages in the project area, those which are shown in Figs. 1, 2 and 3, in the district of Medan Deras, the consecutive endemic onset of cholera has been observed in these three years; that is the reason why the District Medan Deras was selected for the investigation.

The three villages in this district was selected for the sample area by the same reason, as is shown in Table 1, and 2. They are Pangkalan Dodek, Sei Buah Keras and Sidomulio. The area of these three villages is a flat lowland, covered by waste land and small rice fields. Most of dwelling houses of inhabitants are located gathering or scattering along small paths and rivers. Sanitary condition of these villages is, in general, very low. For example, in some area, people have no water supply system and no toilet.

And also, according to weekly report, there were frequent occurrence of small endemic outbreak of cholera or suspect cases.

Fig. 1

Suspected Cholera Cases in KEU. LIMA PULUH

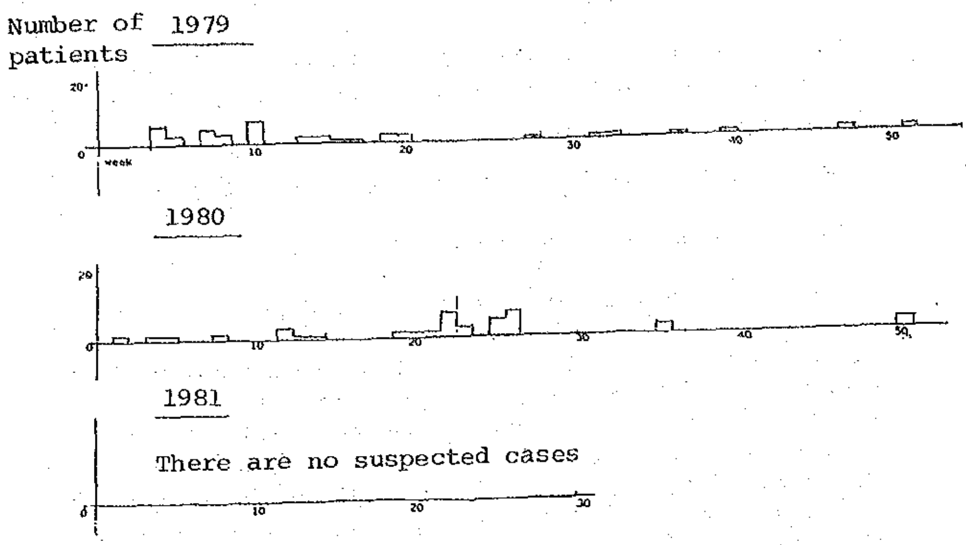


Fig. 2

Suspected Cholera Cases in KEC. AIR PUTIH

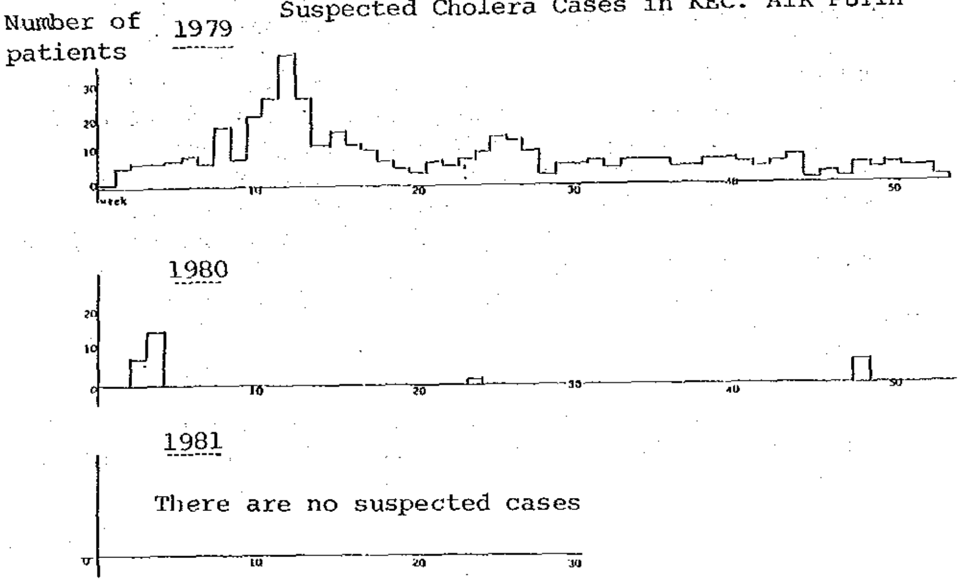


Fig. 3 Suspected Cholera Cases in KEC. MEDAN DERAS

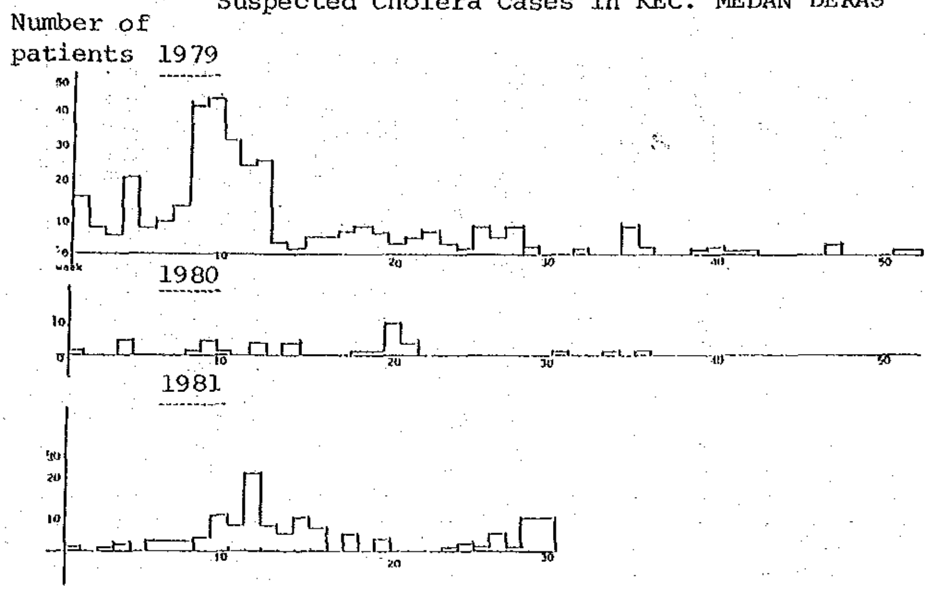


Table 1 Clinically Suspected Cholera Cases in Kec. Medan Deras (1980)

Week	Pkl. Dodek	Sidomulio	Sei Buah Keras	Aek Nauli	Nanasiam	Durian	Medan	Pm. Congkering	Sei Rakyat	Tg. Sigonl	Lalang	Pakom	D. Kalipah (Deli Serdan)	Air Putih	Total
4	-	-	-	-	-	-	2/0	-	-	-	-	-	2/0	-	4/0
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
8	-	-	-	-	-	-	1/0	-	-	-	-	-	-	-	1/0
9	-	-	3/0	-	-	-	-	-	-	-	-	-	-	-	3/0
10	-	-	-	-	-	-	-	1/0	-	-	-	-	-	-	1/0
11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
12	1/0	-	-	-	-	-	-	-	-	-	-	-	-	-	1/0
13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
14	1/0	2/0	-	-	-	-	-	-	-	-	-	-	-	-	3/0
15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
19	-	-	1/0	-	-	-	-	-	-	-	-	-	-	-	1/0
20	-	3/0	-	-	-	-	-	6/0	-	-	-	-	1/0	-	10/0
21	3/0	-	-	-	-	-	-	-	-	-	-	-	-	-	3/0
22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
25	-	-	1/0	-	-	-	-	-	-	-	-	-	2/0	-	3/0
26	-	-	-	-	-	-	-	-	-	-	-	-	1/0	-	1/0
27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
29	-	-	-	-	-	-	-	-	-	-	-	-	1/0	-	1/0
30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
33	-	1/0	-	-	-	-	-	-	-	-	-	-	-	-	1/0
34	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
35	-	-	1/0	-	-	-	-	-	-	-	-	-	-	-	1/0
Total	5/6	6/0	6/0	-	-	-	3/0	7/0	-	-	-	-	8/0	-	35/0

Table 2 Clinically Suspected Cholera Cases in Kec. Medan Deras (1981)

Week	Pkl. Dodek	Sidomulio	Sei Buah Keras	Aek Nauli	Nanasiam	Durian	Medan	Pm. Cengkering	Sei Rakyat	Tg. Sigoni	Lalang	Pakam	B. Kalipah (Deli Serdan)	Air Putih	Total
1	-	-	-	-	-	-	1/0	-	-	-	-	-	-	-	1/0
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
3	-	-	-	-	-	-	1/0	-	-	-	-	-	-	-	1/0
4	1/0	-	1/0	-	-	-	-	-	-	-	-	-	-	-	2/0
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
6	1/0	-	-	-	-	-	2/0	-	-	-	-	-	-	-	3/0
7	1/0	-	1/0	-	-	-	-	-	-	-	-	-	1/0	-	3/0
8	-	-	3/0	-	-	-	-	-	-	-	-	-	-	-	3/0
9	-	-	4/1	-	-	-	-	-	-	-	-	-	-	-	4/1
10	4/0	2/0	5/0	-	-	-	-	-	-	-	-	-	-	-	11/0
11	5/0	2/0	1/0	-	-	-	-	-	-	-	-	-	-	-	8/0
12	7/0	5/0	5/0	1/0	2/0	-	-	-	-	-	-	-	3/0	1/0	24/0
13	4/0	1/0	-	1/0	1/0	-	-	-	-	-	-	-	1/0	-	8/0
14	2/0	2/0	-	-	-	-	-	-	-	-	-	-	1/0	-	5/0
15	7/0	1/0	1/0	1/0	-	-	-	-	-	-	-	-	-	-	10/0
16	2/0	1/0	3/0	-	-	-	-	-	-	-	-	-	1/0	-	7/0
17	1/0	1/0	2/0	2/0	1/0	-	-	-	-	-	-	-	1/0	-	7/0
18	3/0	1/0	-	-	-	-	-	-	-	-	-	-	1/0	-	5/0
19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
20	2/0	-	-	-	-	-	-	-	-	-	-	-	2/0	-	4/0
21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
23	1/0	-	-	-	-	-	-	-	-	-	-	-	-	-	1/0
24	1/0	1/0	-	-	-	-	-	-	-	-	-	-	-	-	2/0
25	-	-	-	-	-	-	-	1/0	-	-	-	-	-	-	1/0
26	3/0	-	-	-	-	-	-	-	-	-	-	-	-	2/0	5/0
27	1/0	-	-	-	-	-	-	-	-	-	-	-	-	-	1/0
28	5/0	-	3/0	2/0	-	-	-	-	-	-	-	-	-	-	10/0
29	6/0	-	2/0	2/0	-	-	-	-	-	-	-	-	-	-	10/0
30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0

② Methods of investigation

Health Center of Pagurawan has been visited every Monday by the team with one of the JICA Experts (the author himself) and one of the counterparts from Medan Health Laboratory. (Principally, a counterpart from the section of cholera and other diarrheal disease control, Department of Communicable Diseases Control, Provincial Health Services, was expected to join in the team. But it was not realized by the reason of budgetary situation.) When some cases/suspects of cholera were reported in the preceding week in the area, the following investigation were carried out by the team accompanying a staff of the Health Center Pagurawan.

1) Household health check

The household of the case/suspect and their neighbouring were visited, and were given health check, using Questions and Answers Form. (Table 3 and 4)

When some new suspects would be detected through health check, specimens of diarrheal stool or vomiting mass might be collected for the Laboratory examination.

2) Collection of water sample

Water samples of daily use by the households of cases/suspects, might be collected for the Laboratory examination.

3) Regular check of Vibrio Cholerae in some environmental water

Water samples of some rivers/wells were collected for the regular check.

a) River Pagurawan

b) Sea Pagurawan

c) Some wells in the village

③ Field activity

The team visited at the households of suspects accompanied by the doctor or one of the nurses of the health center. Questions and Answers inquieries for the household members/ neighbouring were made by the team to fulfill each questionaire or the form, such as name, sex, age, occupation, some environmental factors and others. When available, rectal swabs of the household members and samples of water in the kitchen/well were collected for examination.

As the fact, 35 rectal swabs of the suspects and 17 of the contacts (family and neighbouring) were collected and examined, from 29th June to 25th August 1981.

Table 3 Recording Card for Cholera Suspect Case

No.:______________________ Date:______________________

Name:__________________ Sex: Male, Female Age:__________

Address of Residence:______________________________

Occupation: 1. Farmer 2. Fishman 3. Employee 4. Employer
5. Merchant 6. Shop-worker 7. Daily-worker
8. Student 9. House-keeper 10. No occupation
11. Others.

Environmental Factors:

Dwelling House: 1. Independent house 2. Appartment
3. Rental room 4. Domitory 5. Others

Water Supply (Common/ Independent) : 1. Pipe-lined water supply system (governmental)
2. Pipe-lined water supply system (private)
3. Deep well 4. Shallow well with protection
5. Shallow well without protection
6. Artitificial pool 7. Spring 8. River
9. Rice field 10. Others

Latrine : 1. Governmental drainage
2. Under ground infusion
3. River

Latrine : 1. Exists 2. No
(if exisits)
1. Governmental drainage
2. Under ground infusion
3. River 4. Others
(if no)
1. River 2. Farm field
3. Out door, distant within 10 m
4. Out door, distant more than 10 m
5. Others

Table 4 Recording Card for Cholera Suspect Case

House hold member

No	Name	Sex	Age	Remarks

Behavior status and Food and Drinks

Date	Behavior	Food and drinks		
		Breakfast	Lunch	Supper
Onset				
1 day before				

④ Result of Examination

Fifty two rectal swabs had been collected from the inhabitants at the project area, 37 water samples had been collected from River and Sea Pagurawan and the others, including specimens collected in the city P. Siantar. Twenty strains of V. Cholerae were isolated from their specimens. They were 17 strains from rectal swabs and 3 strains from water samples. No positive results were obtained in the examination of 17 rectal swabs collected from the healthy contacts.

All isolated strains were biotype Eltor serotype OGAWA. Strains of Salmonella and Shigella were not isolated.

The results obtained are shown in the table.

The Detail of the Results

Date	Specimen					Remark
	Rectal Swab		Water			
	Suspects	Contacts	Kitchen	Well	River, Sea	
29/6	7 (5)	7	1	2	1	
6/7	5 (2)	2	-	-	5 (2)*	
					5**	
13/7	3	5	-	-	2	
20/7	9 (4)	-	-	1	3	
27/7	4 (2)	2	-	-	3	
10/8	5 (2)	1	-	2	3	
13/8	-	-	-	-	9 (1)***	
25/8	2 (2)	-	-	-	-	
Total	35 (17)	17	1	5	31 (3)	

Note: Number in parentesis are cases of V. Cholerae positive.

* : V. Cholerae positive samples were collected from the River Pagurawan.

** : 5 water samples were collected in the Pagurawan Sea.

*** : 9 water samples were collected in the city of P. Siantar.

⑤ Drug sensitivity patterns

Drug sensitivity patterns are shown in the Table 5. It is considered drug sensitivity patterns of those strains were the same. But, one case, Ucok's strain was different from the others, because it was resistant to tetracycline (TC), and chloramphenical (CM).

⑥ Summary of the activity

1) Three villages in the district of Medang Deras were selected for the epidemiological study of cholera endemic and the environmental contribution on it.

2) From June to August 1981, 35 clinical suspects of cholera (one of them was collected in the village of Aek Nauli) were observed.

The examination of the specimens collected from suspects, resulted positive to V. Cholerae in 17 specimens as high as 48.5%.

3) In connection with the environmental factors of the endemic, water samples from various sources were examined. Among 26 water samples collected from some rivers (including those in the city of P. Siantar) 3 were proved V. Cholerae positive (11.5%).

(Keiichiro Jo: 1981. Mar. 14 ~ 1981. Sep. 13)

Table 5 Drug Sensitivity Patterns of V. Cholerae

No	Name	Sex	Age	NA	CL	TC	CM	GM	PB	KM	EM
1	Maisarah	F	10	R	R	S	S	R	R	R	R
2	Mastiur	F	12	R	R	S	S	R	R	R	S
3	Mhb. Effendi	M	12	S	-	S	S	-	R	S	R
4	Choiriah	F	4 1/2	S	R	S	S	R	R	R	S
5	Nuraini	F	5	S	R	S	S	S	R	S	S
6	Haris	M	2	S	-	S	S	-	R	S	R
7	p-27 (water)			S	-	S	S	-	R	S	-
8	p-28 (water)			S	-	S	S	-	R	S	-
9	Juriah	F	3	S	-	S	S	-	R	S	-
10	Ucok	M	3	R	R	R	R	S	R	S	R
11	Nurlela	F	7	S	R	S	S	S	R	S	S
12	Pinus	M	19	S	R	S	S	S	R	S	S
13	Amran	M	27	S	R	S	S	S	R	S	R
14	Yusmaniar	F	2 1/2	S	R	S	S	S	R	S	S
15	Lina	F	1 1/2	S	R	S	S	S	R	S	S
16	Rita	F	3 1/2	S	R	S	S	S	R	R	S
17	Fredy	F	1/2	S	R	S	S	S	R	R	S
18	s-1 (water)			S	R	S	S	S	R	S	S
19	Maniah	M	1 1/2	S	R	S	S	S	R	S	S
20	Yaniah	F	9	S	R	S	S	S	R	S	S

Abbreviations; NA = Nalidixic acid, CL = Colistin, TC = Tetracycline, CM = Chloramphenicol, GM = Gentamicin, PB = Polymyxin B, KM = Kanamycin, EM = Erythromycin

(4) Infections of Enteropathogenic Bacteria in the Project Area

① Outline of the project area

The project area covers 56 villages at 3 districts of Asahan Regency in North Sumatra Province, located at longitude 99°40' east and 3°20' north of Equator and in a a low flat land facing Malacca Strait. This area is included in the climate area of tropical rain forest which is not clear in distinction of the dry and rainy seasons. Annual rainfall is 1,400 - 1,800 mm.

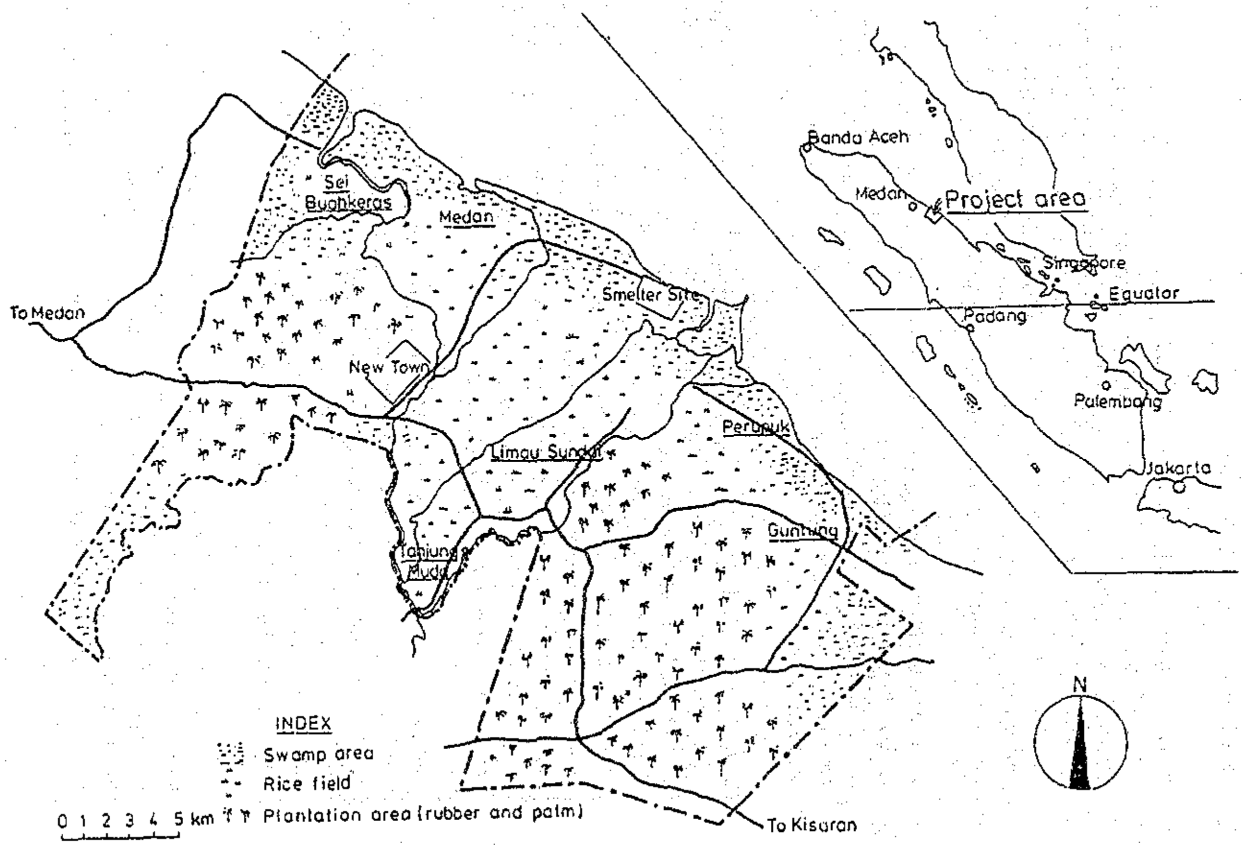
The area might be classified socially and geographically into 3 parts, an aliminium smelter plant being constructed by Indonesia Asahan Aliminium Co. (INALUM) and its related area, plantation area of rubber and oil palm and other villages.

The first area covers a village named to Kwala Tanjung and some other villages. An aluminium smelter plant is being constructed at Kwala Tanjung. There is a national highway from Medan to Kisaran, from which an access road branches to the smelter site. There is a big residential area (new town) for members of the plant along the access road. Areas surrounding the smelter site and the new town are being much influenced socially and economically by the construction of the big plant.

The second area is that of plantations. This area covers most of Lima Puluh district and a part of Air Putih district. Most inhabitants work in the big plantations of rubber and oil palm. They seem to have rather high sanitary levels. For example, they have their own water supply systems and hospitals.

The third area is that of the other villages. These villages seem to be poor in social and sanitary levels. Though these villages are not so far from the smelter site or the new town, inhabitants seem to be estranged to the latter, because these villages are inconvenient in access.

Figure 1 Location Map of the Project Area



Surveys on enteropathogenic bacteria and enteric parasites have been conducted at 6 villages extracted as social, geographical and sanitary representatives of the three areas. Names of villages and periods of the surveys are as follows; Sei Buahkeras (May - July 1979), Limau Sundai (August - December 1979), Perupuk (February - March 1980), Guntung (March - May 1980), Medan (April - June 1980) and Tanjung Muda (July 1980).

Estimated populations of Sei Buahkeras, Medan, Limau Sundai, Tanjung Muda, Perupuk and Guntung are 2,000, 2,900, 3,000, 1,350, 6,000 and 2,500 respectively. Human tribes are Batak and Malay in majority and Javanese, Aceh and Kalimantan in minority. They are mainly engaged in rice farming, while majority in Perupuk and parts in Sei Buahkeras and Medan are engaged in fishery. Rice fields are large in Medan, Limau Sundai and Tanjung Muda and small in Sei Buahkeras, Perupuk and Guntung. In general, houses of Bataks are clustered in small residential areas, while those of the other tribes are scattered in the rice fields. Most Batak people are Christians and the others are Moslems.

Inhabitants live on rice with cooked meats and vegatables supplemented with a lot of minced coconuts and red peppers. In general, they eat foods by hands without chopsticks, spoons or forks.

There are 4 kinds of water supply systems, deep wells, semi-deep wells, shallow wells and rivers, in this area. A deep well around 250 m depth is seen in Guntung. Five semi-deep wells 70 - 90 m in depth are seen in Sei Buahkeras, Medan and Perupuk. Inhabitants having semi-deep wells utilize, sometimes, shallow wells or rivers because water spouting from the semi-deep wells is not enough.

Less than 40% of households have toilets in the 6 villages. Inhabitants having no toilet excrete in bushes or rivers around premises. They breed many chickens and a few ducks, goats, buffaloes or cattle. Some inhabitants breed pigs, who wander around premises, eat and disseminate human feces, excrete freely and contact with children in the day-time. They are kept in cages in the nighttime.

② Method of our field survey

We visited villages once a week which we have informed previously by official letters. Inhabitants were collected in one or two places by a chief or secretary of the village. We accompanied with a doctor or nurses from Health Center and joined with nurses stationed in the village. We explained our purpose and methods of examinations in each places. When inhabitants agreed, we took rectal swabs with informations of each individuals as name, sex, age, tribe, religion, source of drinking water and other necessary informations.

In general, it was difficult to take rectal swabs from healthy inhabitants. We asked nurses stationed in the village or nurses from Health Centers to take rectal swabs. We didn't use any members from Medan because they were not familiar to the inhabitants. We asked male nurses to take specimens from male inhabitants and female nurses to take specimens from female inhabitants. We didn't agree with proposals that inhabitants might take rectal swabs themselves because we worried their technical errors. We took specimens from children when their parent(s) agreed.

We brought drugs to support our activities. They included anti-histamins, antibiotics, vitamin tablets and some drugs when doctors or nurses request. These drugs were given to inhabitants by nurses in their judgements after rectal swabs were taken successfully. After rectal swabs were taken, inhabitants got a small plastic container to collect their own feces. These containers were collected after one week at the beginning of the survey, whose recovery rates were low. So we changed to collect the feces at the next day since we start the survey at the third village.

When our survey were finished at 2 villages, we found that most inhabitants got plural and heavy infections of enteric parasites. Up to these date, we started to give 'Combantrin', anti-helminthic, to cooperators of our activities when their feces were obtained. Thus, recovery rates of feces were increased as follows:

Village	Feces/Rectal/Swab (recovery rate)	Note
Sei Buahkeras	235/ 650 (36.2%)	Combantrin was not used.
Limau Sundai	512/1266 (40.4%)	Combantrin was not used.
Perupuk	296/ 520 (56.9%)	Combantrin was used.
Guntung	274/ 488 (56.1%)	Combantrin was used.
Medan	301/ 543 (55.4%)	Combantrin was used.
Tanjung Muda	166/ 247 (67.2%)	Combantrin was used.

In some area, chiefs and inhabitants at appointed hamlets got no informations about our activities until we visited the area though we sent official letters to chiefs of the villages. In another area, all inhabitants did not co-operate us even if a chief of the village or hamlet agreed us for our activities. In the key persons agreed, most inhabitants followed our activities. If the key persons did not agree, we could not take specimens in these area.

③ Methods to detect enteropathogenic bacteria

A method of Zen-Yoji et al. (1976)* was used with minor modifications to isolate and identify enteropathogenic bacteria.

Rectal swabs were taken from volunteers, transported to Regional Health Laboratory in Medan in Cary-Blair media (Difco), inoculated on SS agar plates (Eiken) directly and in Selenite brothes (Difco) and alkaline peptone waters (Difco) as enrichment and incubated overnight at 37°C. The SS agar plates were incubated overnight at 37°C and 2 days at room temperature. Suspected colonies of Salmonella or Shigella on direct cultures of SS agar plates were transferred to TSI (Eiken) and LIM (Nissui) media and incubated overnight at 37°C. Suspected colonies of Yersinia on direct cultures of SS agar plates were transferred to TSI and LIM media and incubated for 2 days at room temperature. Isolates showed reactions of

Salmonella, *Shigella* or *Yersinia* were confirmed by slide agglutination tests with antisera (Toshiba) and additional biochemical reactions on Simmons citrate, VP-Semisolid and KCN media (Eiken). Selenite broth cultures were transferred on SS agars and incubated overnight at 37°C. Suspected colonies of *Salmonella* on SS indirect cultures were transferred to TSI and LIM media and confirmed by agglutination tests and additional biochemical reactions. Alkaline peptone cultures were transferred on TCBS agars (Eiken) and incubated overnight at 37°C. Suspected colonies of *Vibrio cholerae* on TCBS agars were also transferred on TSI and LIM media. Suspected colonies of *Vibrio parahaemolyticus* on TCBS agar were transferred to TSI and LIM media with 3% NaCl. Suspected isolates of *Vibrio* were confirmed with agglutination tests and biochemical reactions. Toxinogenic *Escherichia coli* was not examined because of limitations of facilities.

* H. Zen-Yoji, M. Ohashi and Y. Kudoh (ed.). Manual for the isolation and identification of enteropathogenic bacteria. Southeast Asian Medical Information Center, Tokyo (1976).

④ Drug sensitivity tests of isolated bacteria

0.05 ml of overnight broth cultures of isolated bacteria were spread on sensitivity agar plates and incubated overnight with Tridisks (Eiken) including nalidixic acid, kanamycin, aminobenzylpenicillin, methylchlorophenylisoxazolylpenicillin, sulbenicillin, chloramphenicol and tetracycline and Monodisks (Showa) including streptomycin and sulfamonomethoxin and read the results.

RESULTS AND DISCUSSIONS

⑤ Enteropathogenic bacteria isolated in the 6 villages

We have collected rectal swabs from 3,729 inhabitants in the 6 villages, from which 16 strains of *Shigella*, one strain of *Salmonella* and 5 strains of *Vibrio parahaemolyticus* were isolated (Tables 1 and 2). *Vibro cholerae* and *Yersinia enterocolitica* were not isolated. Overall prevalence ratio of enteropathogenic bacteria was 0.59%.

Shigella was isolated at 5 villages sporadically. Most dominant Shigella species was S. sonnei and the next was S. flexneri. Prevalence ratio of Shigella was significantly higher in Sei Buahkeras than that in the other villages ($p < 0.01$). Only one Salmonella was isolated at Tanjung Muda. V. parahaemolyticus was found at Medang and Guntung.

In Perupuk and Tanjung Muda, each 2 positive cases were found in the same family members. Eleven Shigella positive cases had clinical symptoms as diarrhoea, bellyache or fever (Table 2), which means that case finding of dysentery might be not so difficult if doctors or nurses contact with inhabitants frequently. If they find suspected cases, they must take rectal swabs to send to the laboratory, take suitable treatments and disinfect belongings of the patient. For this purpose, some antibiotics and disinfectants must be kept in all health centers. Establishment of these systems seems to be not so difficult because rehydration systems of cholera have run in this area.

⑥ Bacteia isolated from a small cholera epidemic in Perupuk

On the 26th of May in 1980, a small cholera epidemic started from a woman, 70 years old, living in hamlet X, Perupuk and spread among inhabitants attended her funeral. Rectal swabs were collected from 14 inhabitants (clinically suspected cholera cases and contact persons on the 4th of June 1980), from which 2 strains of V. cholerae Eltor Ogawa and one strain of S. flexneri 1b were isolated (Table 1 and 2).

Route of infection of the first case was not specified. However, there was a big cholera epidemic in North Sumatra since August 1978 as described in the following section. When our samplings have done in Perupuk, cholera epidemics were reported in Medang Deras and Tanjung Tiram districts in Asahan regency, west and east adjacent places of Perupuk. Many inhabitants in Perupuk go to fish markets in these areas. Thus, invasions of the bacteria from these areas might not be negligible.

Table 1 Enteropathogenic Bacteria Isolated in the Project Area

Bacteria	Villages						
	Sei Buahkeras (n=650*)	Medang (n=544)	Limau Sundai (n=1266)	Tanjung Muda (n=247)	Perupuk (n=520+14**)	Guntung (n=488)	Total (n=3729)
Shigella dysenteriae 2	–	–	1***	–	–	–	1
Shigella flexneri 1b	–	–	–	–	1**	–	1
Shigella flexneri 2a	3	–	–	–	–	–	3
Shigella flexneri 6	1	–	–	–	–	1	2
Shigella sonnei	5	–	2	1	2	–	10
Salmonella bovis-morbificans	–	–	–	1	–	–	1
Vibrio parahaemolyticus	–	3	–	–	–	2	5
Vibrio cholerae	–	–	–	–	2**	–	2

N. H. Kumazawa & S. Sinulingga, 1980

* Number of specimens examined
** Survey of cholera (4 June 1980)
*** Number of positive specimens

Table 2 Epidemiological Features of Enteropathogenic Bacteria Positive Cases in the Project Area

Bacteria	Date of sampling	Place	Age/Sex	Water source	Clinical features
Shigella flexneri 2a B-410	4 June 1979	Sei Buahkeras Lr. VI	3/M*	Shallow well	2 weeks ago diarrhoea
Shigella flexneri 2a B-437	11 June 1979	Sei Buahkeras Lr. III	5/F	Shallow well	-
Shigella flexneri 2a B-830	16 July 1979	Sei Buahkeras Lr. VI	17/F	Shallow well	-
Shigella flexneri 6 B-588	18 June 1979	Sei Buahkeras Lr. I	50/F	Semi-deep well	yesterday diarrhoea
Shigella sonnei B-348	4 June 1979	Sei Buahkeras Lr. IV	7/M	Shallow well	frequently bellyache
Shigella sonnei B-488	11 June 1979	Sei Buahkeras Lr. VI	7/M	Shallow well	-
Shigella sonnei B-629	25 June 1979	Sei Buahkeras Lr. VII	3/F	Shallow well	-
Shigella sonnei B-688	25 June 1979	Sei Buahkeras Lr. VII	4/F	River	now diarrhoea
Shigella sonnei B-735	2 July 1979	Sei Buahkeras Lr. IV	3/F	Shallow well	2 days ago diarrhoea with blood
Shigella dysenteriae 2 L-53	6 Aug. 1979	Limau Sundai Lr. IX	16/F	Shallow well	now fever
Shigella sonnei L-1208	26 Nov. 1979	Limau Sundai Lr. IV	7/F	Shallow well with sand filter	2 weeks ago diarrhoea
Shigella sonnei L-1266	2 Dec. 1979	Limau Sundai Lr. XIII	5/F	Shallow well	
Shigella sonnei P-556	10 Mar. 1980	Perupuk Lr. XII	13/F	Shallow well →	{1 week ago diarrhoea now feces with blood
Shigella sonnei P-561	10 Mar. 1980	Perupuk Lr. XII	1/F	Shallow well	now diarrhoea, sibling of case P-556
Vibrio cholera eltor Ogawa P-7	4 June 1980	Perupuk Lr. X	2/F	Shallow well	- (sibling of cholera case P-8)
Vibrio cholerae eltor Ogawa P-8	4 June 1980	Perupuk Lr. X	70/F	Shallow well	cholera patient
Shigella flexneri 1b P-12	4 June 1980	Perupuk Lr. X	2/M	Shallow well	- (sibling of cholera case P-8)
Shigella flexneri 6 G-113	25 Mar. 1980	Guntung Lr. II	7/M	Deep well	1 week ago diarrhoea
Vibrio parahaemolyticus K8 G-470	10 May 1980	Guntung Lr. VI	45/F	Deep well	now bellyache
Vibrio parahaemolyticus K15 G-510	10 May 1980	Guntung Lr. VI	3/F	Shallow well	-
Vibrio parahaemolyticus M-262	5 May 1980	Medang Kwala Sipare	6/M	River	-
Vibrio parahaemolyticus M-550	16 June 1980	Medang Kwala Sipare	7/M	River	- (congenital heart failure)
Shigella sonnei T-148	14 July 1980	Tanjung Muda Lr. IV	4/F	Shallow well	2 days ago diarrhoea
Salmonella bovis-morbificans T-153	14 July 1980	Tanjung Muda Lr. IV	45/F	Shallow well	- (mother of case T-148)
Vibrio parahaemolyticus K15 M-510	3 June 1980	Medang Kwala Sipare	12/F	River	1 week ago diarrhoea

* Abbreviations: M = male, F = female

N. H. Kumazawa & S. Sinulingga, 1980

⑦ Relationship between enteropathogenic bacteria positive cases and sources of drinking water

Table 3 shows relationship between positive cases of enteropathogenic bacteria and sources of drinking water in the 6 villages.

Bacterial dysentery was found to be endemic in this area. In Sei Buahkeras, prevalence ratio of Shigella among inhabitants utilizing semi-deep wells (1/263; 0.38%) was lower significantly than those utilizing shallow wells (7/281; 2.49%) ($p < 0.05$). As a whole, however, differences of the prevalence ratios among those utilizing different water sources were not clear.

Two Shigella positive cases were found from those utilizing deep and semi-deep wells. In general, utilization of water seems to be not so strict in this area. They utilize waters from shallow wells or rivers for cooking, washing and bathing even if they appeal to utilize water from deep wells. Thus, 2-dysentery cases among those utilizing deep and semi-deep wells might be reasonable.

V. parahaemolyticus infections were also common. In Medang, V. parahaemolyticus was detected at a coastal area, hamlet Kwala Sipare. Inhabitants in this hamlet have utilized river and sea waters usually and bought water for drinking from other hamlets because they could not find water without salinity in this hamlet. Thus, V. parahaemolyticus might contaminate easily to their foods. This bacterium is known to be highly contaminated in sea foods in this area.

Salmonella was isolated from one inhabitant in Tanjung Muda. More surveys might support further analyses of this bacterial species in this area.

In Perupuk and Tanjung Muda, 2 positive cases of Shigella and Salmonella were found in the same family members. Contaminated foods or drinks might be the common cause of these cases.

There are only one deep and a few semi-deep wells in the 6 villages. Water spouting from these semi-deep wells is not enough. Thus, inhabitants were obliged to utilize water from shallow wells or river even if they had semi-deep wells. Mechanical pump-up of semi-deep wells might not be suitable because social levels might be still low to maintain machinery. Thus, in this area, constructions of deep wells might be essential to control these bacterial infections.

Table 3 Relationship between Enteropathogenic Bacteria Positive Cases and Sources of Drinking Water

Village	Deep and semi-deep wells	Shallow well	River	Total
Sei Buahkeras	1/263*	7/ 281	1/106	9/ 650
Medang	0/ 17	0/ 495	3/ 32	3/ 544
Limau Sundai	-	3/1199	0/ 67	3/1266
Tanjung Muda	-	2/ 247	-	2/ 247
Perupuk	0/ 31	2/ 489	-	2/ 520
Guntung	2/408	1/ 80	-	3/ 488
Total	3/719	15/2791	4/205	22/3715

* Number positive/number examined.

N. H. Kumazawa & S. Sinulingga, 1980

⑧ Participation of pigs to infections of enteropathogenic bacteria

Table 4 shows relationship between positive cases of enteropathogenic bacteia and breeding pigs. All of V. parahaemolyticus was found in community without pigs. For the other bacteria, no difference among communities with and without pigs was seen. In general, V. parahaemolyticus might be contaminated in sea foods. Though it is not yet certified that 2 groups of inhabitants might be different in manner to take sea foods or in amount of sea foods which they take, contributions of pigs seem to be not so important for infections of enteropathogenic bacteria.

Contributions of rice field area, breeding pigs and water sources to infections of enteropathogenic bacteria were summarized in Table 5.

Table 4 Participation of Pigs to Infections of Enteropathogenic Bacteria

Village	Community with pigs	Community without pigs	Total
Sei Buahkeras	6/ 453*	3/ 197	9/ 650
Medang	-	3/ 544	3/ 544
Limau Sundai	3/1197	0/ 69	3/1266
Tanjung Muda	0/ 176	2/ 71	2/ 247
Perupuk	-	2/ 520	2/ 520
Guntung	0/ 7	3/ 481	3/ 488
Total	9/1833	13/1882	22/3715

* Number positive/number examined

Table 5

Prevalences of enteropathogenic bacterial infections classified by rice field area, breeding pigs and water supply system

Community	Large rice field area*	Small rice field area**	Total
Community breeding pigs			
Deep and semi-deep wells	-	1/245	1/245(0.41%)***
Shallow well	3/1311	4/146	7/1457(0.48%)
River	0/ 62	1/ 69	1/ 131(0.76%)
Sub-total	3/1373 (0.22%)	6/460 (1.30%)	9/1833(0.49%)
Community without pigs			
Deep and semi-deep wells	0/ 17	2/ 457	2/ 474(0.42%)
Shallow well	2/ 630	6/ 704	8/1334(0.60%)
River	3/ 37	0/ 37	3/ 74(4.05%)
Sub-total	5/ 684 (0.73%)	8/1198 (0.67%)	13/1882(0.69%)
Total	8/2057 (0.39%)	14/1658 (0.84%)	22/3715(0.59%)

*A total of 3 villages, Medang, Limau Sundai and Tanjung Muda.
**A total of 3 villages, Sei Buahkeras, Perupuk and Guntung.
***Number positive/number examined(prevalence ratio).

Table 6

Drug sensitivity patterns of bacteria isolated in the project area

Bacteria	NA*	KM	PcA	PcC	PcS	CM	TC	SM	SA
Shigella flexneri 2a B-410	S*	S	S	R	S	R	R	R	R
Shigella flexneri 2a B-437	S	S	S	R	S	R	R	R	R
Shigella flexneri 2a B-830	S	S	S	R	S	R	R	R	R
Shigella flexneri 6 B-588	S	S	S	R	S	S	S	#	#
Shigella sonnei B-348	S	S	S	R	S	S	S	S	R
Shigella sonnei B-488	S	S	S	R	S	S	S	#	#
Shigella sonnei B-629	S	S	S	R	S	R	R	R	R
Shigella sonnei B-688	S	S	S	R	S	S	S	S	R
Shigella sonnei B-735	S	S	S	R	S	R	R	R	R
Shigella dysenteriae 2 L-53	S	S	S	R	S	S	S	S	R
Shigella sonnei L-1208	S	S	R	R	S	R	R	#	#
Shigella sonnei L-1266	S	S	R	R	S	S	S	S	R
Shigella sonnei P-556	S	S	S	R	S	S	S	S	R
Shigella sonnei P-561	S	S	S	R	S	S	S	S	R
Shigella flexneri 1b P-12	S	S	R	R	R	R	R	R	R
Shigella flexneri 6 G-113	S	S	S	R	S	S	S	S	R
Shigella sonnei T-148	S	S	S	R	S	R	R	R	R
Salmonella bovis-morbificans T-153	S	S	S	R	S	S	S	R	R

*Abbreviations : NA=nalidixic acid, KM=kanamycin, PcA=aminobenzylpenicillin, PcC=methylchlorophenylisoxazolylpenicillin, PcS=sulbenicillin, CM=chloramphenicol, TC=tetracycline, SM=streptomycin, SA=sulfisoxazol, S=sensitive, R=resistant, #=not examined.

⑨ Drug sensitivity patterns of Shigella and Salmonella

Drug sensitivity patterns of Shigella and Salmonella isolated in the 6 villages are shown in Table 6. Eight strains of Shigella were resistant to chloramphenicol and tetracycline. Seven strains of Shigella and one strain of Salmonella were resistant to streptomycin. Resistances to chloramphenicol, tetracycline and streptomycin were linked for all resistant strains. Three strains of Shigella were resistant to aminobenzylpenicillin.

We are anxious about these results because clinicians have used chloramphenicol and tetracycline usually to clinically suspected dysentery cases without any bacteriological checks in this area. For example, S. Dysenteriae L-53 was isolated in Limau Sundai just after treatments using chloramphenicol and tetracycline. This strain was sensitive to these drugs. If these treatments might be suitable, we could not isolate chloramphenicol or tetracycline sensitive Shigella strain. Recently, many chickens have been carried into this area after much amount of antibiotics had been prescribed. From these circumstances, heavy disturbances of enteric flora caused from misuse of antibiotics should be worried of.

(Norichika Kumazawa: 1978. Nov. 17 ~ 1980. Nov. 16)

(5) Viral Infections

In Java islands, studies on rotavirus infections revealed that especially in young children rotavirus is the most important causative agent in acute diarrhoeas. This is briefly investigated in North Sumatra (52.4% virus positive in stool of 21 children with acute gastroenteritis, Urasawa et al., 1981) but further study would be necessary to elucidate the situation in the project area.

(Akira Ishii)

(6) Parasitic Infections

① General Remark

World Health Organization published the group study on parasitic infections causing diarrheal diseases. In that some infections such as amebiasis, giardiasis, strongyloidiasis, trichuriasis were listed other than hookworm and Ascaris infections. Past study in Sumatra revealed 7% stool positive and 13% seropositive for Entamoeba histolytica. In some area of North Sumatra 6% stool positive was reported.

In Sumatra, stool positive rate for giardiasis range between 4-6%. These protozoan infections has not been investigated in North Sumatra. These parasite-related diarrheas must receive attention considering regional or local distribution of these infections as mentioned in WHO report (WHO/CDD/PAR/80/1). (Akira Ishii)

② Infections of intestinal parasites in the project area (1979/1980)

1) Introduction

Asahan Regency is a typical rural area of North Sumatra Province, Indonesia facing Malacca Strait. Social status of this area is changing with the construction of an aluminium smelter plant. As the industrial development progress, undesirable impacts on health have been warned. Thus, it was requested to obtain basic data on enteric diseases of native inhabitants to prevent risks of all inhabitants in Asahan area.

Recently, some intestinal parasites were detected in North Sumatra including a village of Asahan area (Cross et al., 1976; Stafford and Joesoef, 1976). Some trials on treatments of Ascaris and hookworm infections in this area were also reported (Kosin, 1975). However, risk factors associated with these parasitic infections were not clear.

Parasitological surveys have been conducted at 6 villages extracted as social and geographical representatives of 3 districts in Asahan Regency surrounding the smleter site. Names of villages and periods of the surveys are as follows; Sei Buahkeras (May - July 1979), Limau Sundai (August - December 1979), Perupuk (February - March 1980), Guntung (March - May 1980), Medang (April - June 1980) and Tanjung Muda (July 1980).

2) Materials and methods

Inhabitants were given small plastic container to collect feces specimen in the last morning, which was examined by Kato's thick smear technic (Komiya et al., 1960), flotation on saturated saline and MGL-method (Suzuki, 1975). To detect cysts of protozoa, specimens were examined after iodine staining of formaline-ether sediments. Species of hookworm larvae were identified using test tube cultivation method (Suzuki, 1975). Informations on age, sex, occupation and other social factors for each individuals were obtained by hearing from them. Results were shown in age groups of every 2 years for children, whereas those obtained from age groups of 15 years or more were shown in 2 groups, 15 - 30 and 31 years or more because of insufficient specimen numbers and unreliable informations of exact age in each individuals. Contributions of the epidemiological factors to each parasitic infections were evaluated using χ^2-test.

3) Results

Intestinal parasites detected in the 6 villages

A total of 1,784 feces specimens from the 6 villages was examined and intestinal parasites detected are listed in Table 1. The overall prevalence ratios were 77.5% for Ascaris lumbricoides, 88.2% for Trichuris trichiura and 60.5% for hookworms. Hymenolepis nana and Enterobius vermicularis were found in 4 and 2 specimens respectively. Entamoeba histolytica was common in Limau Sundai but not in other villages. Entamoeba coli and Giardia lamblia were found in 55 and 41 specimens respectively. Blastocystis hominis, Iodamoeba bütshlii and Chilomastix mesnili were not common. A total of 1,741 specimens (97.6% of total specimens) was contaminated with at least one kind of helminth. Twenty eight of 43 parasite-free were 2 years of age or below.

Prevalences of 3 dominant helminthic infections

Figure 1 shows prevalences of 3 dominant helminthic infections in different age groups of inhabitants in the 6 villages. Most inhabitants got A. lumbricoides and T. trichiura infections before 5 years of age, though hookworm infections were rather delayed to reach the highest level in the age group of 11 - 12 years. Prevalence ratio of A. lumbricoides infections fell significantly in the age group of 15 - 30 years or more. Prevalence ratio of hookworm infections fell significantly in the age group of 15 - 30 years and increased again in the age group of 31 years or more.

Ascaris lumbricoides infections

Prevalences of *A. lumbricoides* infections were found to be correlated with ratios of rice fields in a total area ($r = -0.836$, $t = 5.048$) (Fig. 2). The prevalences in area having large rice fields were lower significantly than those in area having small rice fields in most age groups (Fig. 3). Breeding pigs was found to decrease prevalences of *A. lumbricoides* infections (Fig. 4).

Prevalences of *A. lumbricoides* infections classified by 3 epidemiological factors are summarized in Table 2. The difference in the prevalences among large and small rice field areas ($\chi^2 = 19.62$; $p < 0.001$) was a little more than that in those among areas with and without pigs ($\chi^2 = 17.03$; $p < 0.001$). Significant difference in the prevalences of *A. lumbricoides* infections was also seen among different water supply systems. The prevalence in those utilizing deep and semi-deep wells (238/285; 83.5%) was significantly higher than that in those utilizing shallow wells (1080/1412; 76.5%) ($\chi^2 = 6.34$; $p < 0.05$), though the prevalence in those utilizing rivers (64/87; 73.6%) was not different significantly from the other 2 groups.

Figure 5 shows prevalences of *A. lumbricoides* in infections in males and females in different age groups. The prevalence rate fell significantly in adult males but not in adult females.

Trichuris trichiura infections

Prevalences of *T. trichiura* infections were found to be slightly correlated with ratios of rice fields in a total area ($r = -0.356$, $t = 2.967$). The difference was not seen in any age groups among those having large and small rice field areas (Fig. 6). Breeding pigs, however, was found to decrease the prevalence ($\chi^2 = 6.65$; $p < 0.01$) (Fig. 7, Table 3). The prevalence in those utilizing deep and semi-deep wells (269/285; 94.4%) was significantly higher than that in those utilizing shallow wells (1223/1412; 86.6%) ($\chi^2 = 12.76$; $p < 0.001$), though the prevalence in those utilizing rivers (82/87; 94.3%) was not different significantly with the other 2 groups (Table 3). The prevalences were not different significantly among males and females in any age groups (Fig. 8).

Hookworm infections

Prevalences of hookworm infections were found to be correlated with ratios of rice fields in a total area ($r = 0.925$, $t = 5.361$) (Fig. 9). The difference was clear in most age groups among those having large and small rice field areas (Fig. 10). Breeding pigs was found to increase prevalences of hookworm infections in the age groups of 5 - 6 years or more (Fig. 11).

Prevalences of hookworm infections classified by the 3 epidemiological factors are summarized in Table 4. The difference in the prevalences among large and small rice field areas ($\chi^2 = 309.86$; $p < 0.001$) was more than that in those among areas with and without pigs ($\chi^2 = 115.45$; $p < 0.001$). The effect of breeding pigs was seen in small rice field area but not in large rice field area, which suggests that the effect of large rice fields might overcome that of breeding pigs. The overall prevalence ratio of hookworms in those utilizing deep and semi-deep wells (104/285; 36.5%) was significantly lower than that in those utilizing shallow wells (921/1412; 65.2%) ($\chi^2 = 80.67$; $p < 0.001$) and in those utilizing rivers (55/87; 63.2%) ($\chi^2 = 18.38$; $p < 0.001$), though the contribution of water supply systems to be less than those of rice fields or breeding pigs.

The prevalences were not different significantly among males and females in any age groups (Fig. 12).

Table 5 shows results of cultures of some hookworm positive feces specimens, in which dominant hookworm species was found to be Necator americanus. Ancylostoma duodenale was not so prevalent in this area.

Contribution of 4 factors to 3 main protozoa infections

Contributions of 4 epidemiological factors to 3 main protozoa infections are summarized in Table 6.
E. histolytica infections were high in number in large rice field area, community utilizing shallow wells and community breeding pigs, which might reflect the extremely high prevalence of this protozoa in Limau Sundai.
E. histolytica infections were not different significantly among males and females in any age groups. E. histolytica infection was not found in the age group of 0 - 2 years.

E. coli infections were more in females than in males ($\chi^2 = 6.84$; $p < 0.01$). *E. coli* infection was not found below one year. Prevalence Rate of *E. coli* infections in the age groups of 1 - 14 years was not different significantly among males (14/640; 2.2%) and females (20/575; 3.5%), though that in 15 years or more was higher significantly in females (18/303; 5.9%) than in males (3/204; 1.5%) ($\chi^2 = 5.06$; $p < 0.05$).

For *G. lamblia* infections, epidemiologically significant variations in the prevalence was not seen other than those among different water sources.

4) Discussion

A survey on human intestinal parasitic infections was made in rural areas of North Sumatra. At least one kind of helminth was found in feces specimens from 97.6% of volunteers, in which *A. lumbricoides*, *T. trichiura* and hookworms were dominant. *H. nana* and *E. vermicularis* were also detected in low ratios. Scotch tape swab method (Hunter et al. (ed.), 1967) might detect *E. vermicularis* more effectively. *E. histolytica*, *G. lamblia*, *E. coli*, *B. hominis*, *I. bütschlii* and *C. mesnili* were also detected in low ratios.

Prevalence of *A. lumbricoides* infections was found to be correlated with area of rice fields. It might be difficult to consider the cause as that those living in small rice field areas can stay at home for rather long time than those living in large rice field areas. Slight correlation of *T. trichiura* infections with area of rice fields might be caused from high prevalence and also possibly low rate of eliminations of this worm.

Breeding pigs was found to decrease prevalences of *A. lumbricoides* and *T. trichiura* infections. Jones (1976) suggested the role of pigs to assist the spread of *A. lumbricoides* through pig intestine in Papua New Guinea, where pigs dug up and ate buried human feces. In North Sumatra, they have no custom to bury their own feces. Thus, most of human feces remain on the ground at the excreting sites around premises. In area breeding pigs, a part of human feces is eaten by pigs, in which eggs of *A. lumbricoides* and *T. trichiura* might be inactivated, though the possibility of pigs to excrete active human parasites is not negligible. Thus, in North Sumatra, only a few feces with active eggs of *A. lumbricoides* and *T. trichiura* might be left on the ground in community breeding pigs, which might cause less prevalences of *A. lumbricoides* and *T. trichiura* infections in community breeding pigs than in community without pigs. The role of pigs in Papua New Guinea is supposed that pigs disseminate *A. lumbricoides* eggs attached on the skin.

Prevalence ratios of *A. lumbricoides* and *E. coli* infections fell in adult males. Adult females might have high chances to take human feces in home works as cooking, washing or nursing, which might overcome the immunological eliminations of these worms.

Prevalence of hookworm infections was found to be correlated with area of rice fields, which suggests that hookworm larvae might cause infections percutaneously in rice field areas. The stimulation of hookworm infections by breeding pigs was clear in small rice field areas but not in large rice field areas, which suggests that rice field might be a primary factor to regulate the prevalence and that breeding pigs might be a secondary factor to stimulate the infections. Results of cultures also support these speculations, in which *N. americanus* was predominant and *A. duodenale* was not so much in this area. Main portal of entry of the former is known to be percutaneous, whereas that of the latter is per os.

Contribution of pigs to hookworm infections was speculated by Jones (1976), suggesting that hookworm eggs were dug up with buried human feces and destroyed in pig intestine in Papua New Guinea. In North Sumatra, inhabitants leave their feces on the ground so that human feces are attached easily on pig skins and disseminated all over the residential areas. In community without pigs, most of human feces might be left at the excreting sites because of no animal vehicle, which might cause lower prevalence of hookworms.

From these observations, we suppose that pigs have dual functions for infection cycles of human worms; one is a biological filter for these worm infections per os and another is a disseminator for hookworm infections. Rain water and winds might also help to disseminate human feces.