PN-AAE-360
PAS.A RA(HA)-7-00 Res.
REW.PHE/PHC

2-66

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
BUREAU OF DISEASE PREVENTION AND ENVIRONMENTAL CONTROL
NATIONAL
COMMUNICABLE DISEASE CENTER
Atlanta, Georgia 30333

NATIONAL
COMMUNICABLE DISEASE CENTER
MALARIA ERADICATION PROGRAM
EVALUATION SECTION

MALARIA PROGRAM REVIEW - THAILAND
MARCH 4 - 25, 1967

U.S DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
BUREAU OF DISEASE PREVENTION AND ENVIRONMENTAL CONTROL
NATIONAL
COMMUNICABLE DISEASE CENTER
ATLANTA GEORGIA 30333

CONTENTS

GLOSSARY v

FORMS USED IN SURVEILLANCE OPERATIONS vii

FOREWORD 1

ACKNOWLEDGEMENTS 2

CONCLUSIONS 3

BACKGROUND TO THE REVIEW 7

- A. General 7
- B. Administrative Structure 8
- C. Requirements for Spraying Operations 8
- D. Requirements for Surveillance 9

EPIDEMIOLOGY OF MALARIA IN THAILAND 11

- A. Historical 11
- B. The Situation at December 31, 1966 15
- C. Current Concepts 15

METHODS 17

REGION I SURVEY – ZONE PAKCHONG 19

- A. Background 19
- B. Current Status of Malaria Eradication in Zone Pakchong 20
- C. Spraying Operations 22
- D. Surveillance Network 23
- E. Laboratory Services 23
- F. Assessment of Zone Pakchong 24
- G. Conclusions 24

CHLOROQUINE-RESISTANT FALCIPARUM MALARIA IN THAILAND 25

- A. Background 25
- B. Methods 25
- C. Presumptive Treatment 25
- D. Radical Treatment 26
- E. Other Observations 27
- F. Assessment 27
- G. Conclusions 27

REGION 2 SURVEY 29

- Introduction 29
- A. Current Status of Malaria Eradication 29
- B. Spraying Operations 29
- C. Reliability of Communication of Data and Data Presentation 37
- D. Surveillance Network 38
- E. Laboratory Services 45
- F. Supervision 47
- G. Special Epidemiologic Observations 47

CONTENTS *(Continued)*

REGION 3 SURVEY 51

Introduction 51
A. Current Status of Malaria Eradication 51
B. Spraying Operations 54
C. Reliability of Communication of Data and Data Presentation 56
D. Surveillance Network 57
E. Laboratory Services 65
F. Supervision 67

REGION 4 SURVEY 75

Introduction 75
A. Current Status of Malaria Eradication 75
B. Spraying Operations 78
C. Reliability of Communication of Data and Data Presentation 84
D. Surveillance Network 85
E. Laboratory Services 93
F. Supervision 96
G. Special Epidemiologic Observations 96

REGION 5 ZONE 7 99

Notes on the Canton of Samkhok 99

APPENDIX I

Terms of Reference – Purpose and Scope of Malaria Program Review 101

APPENDIX II

Itinerary of the Team 103

APPENDIX III

Extracts from the Thailand Entomological Report by Dr. David D. Bonnet 105

APPENDIX IV

Surveillance Operations Extract from Thailand NMEP Plan of Operations – July 1965 111

APPENDIX V

Map of Thailand – Showing Operational Areas in 1967 113

GLOSSARY

ABER - Annual Blood Examination Rate

ACD - Active Case Detection

API - Annual Parasite Incidence

MEP - Malaria Eradication Program of NCDC

NCDC - National Communicable Disease Center

NIAID - U. S. National Institute for Allergy and Infectious Diseases

NMEP - National Malaria Eradication Project of Thailand

PCD - Passive Case Detection

PCV - Peace Corps Volunteers

RTG - Royal Thai Government

SEATO - South East Asia Treaty Organization

SPR - Slide Positivity Rate

USAID or AID - United States Agency for International Development

UNICEF - United Nations Children's Fund

USPHS or PHS - United States Public Health Service

WHO - World Health Organization

FORMS USED IN SURVEILLANCE OPERATIONS

Forms MS 1. Village register for active case detection. A book carried by each house visitor.

MS 1a. Daily performance report of surveillance workers. House visitor's record of his daily performance.

MS 1b. Fixed Schedule of surveillance workers. Prepared by house visitor and his squad chief.

MS 1c. Fixed Schedule of surveillance squad chief, Prepared by squad chief and sector chief.

MS 1d. Monthly performance report of house visitors. Summary prepared by squad chief from MS 1a.

MS 2. Record of blood smears taken. Record of ACD activities of the house visitor.

MS 3. Monthly report of ACD. Prepared by zone with cooperation of the laboratory.

MS 4. Record of blood smears taken by PCD. Filled in by volunteers and sent in with blood films.

MS 5. Monthly report of PCD. Prepared by zone office in cooperation with the lab.

MS 6. Investigation report of malaria case. Prepared by sector chief.

MS 6a. Report of malaria focus investigation. Prepared by chief of Malaria Investigation Team.

MS 7. Monthly report of malaria case investigation. Summary of zone case investigators.

MS 8. Malaria case registration book. Compiled in book form in zone and sector.

L5a Report from laboratory to sector of slides positive for malaria.

L5c Report from laboratory to sector of unsatisfactory slide preparation.

FOREWORD

This field review of the Thailand National Malaria Eradication Project (NMEP) was undertaken by a team from the Evaluation Section of the Malaria Eradication Program of the National Communicable Disease Center (MEP/NCDC) in Atlanta, Georgia. Its purpose was to define the current strengths and needs of the NMEP in Thailand and to gain an appreciation of how the technical resources of the NCDC could be utilized best in supporting the national efforts to achieve eradication. The review was basically field-oriented and its terms of reference are at Appendix I.

The team consisted of:

D.J.M. MacKenzie, M.B., F.R.C.P., D.P.H., Team Leader
Chief, Research Section, MEP/NCDC

David Holden, M.D., Deputy Team Leader
Epidemiologist, Evaluation Section, MEP/NCDC

William Chin, M.D., M.P.H.
Head of the Unit on Human Malaria
U. S. Penitentiary, Atlanta, Georgia
Laboratory of Parasite Chemotherapy
National Institute for Allergy and Infectious Diseases

F. Marc LaForce, M.D.
Epidemiologist, Epidemic Intelligence Service, NCDC

John Mueller, M.D.
Epidemiologist, Epidemic Intelligence Service, NCDC

The team visited Thailand from March 4 to March 31 and the itinerary is at Appendix II.

Each of the five regions of the Thailand NMEP was visited by at least two members of the team, as were problem areas in Regions 1 and 5. Examination of the data in depth at zone and sector level was carried out in Regions 2, 3, and 4, in each of which one member of the team spent continuous periods ranging from 12 to 14 days.

Prior to starting the field review the team had discussions with the Headquarters Staff of the NMEP, the World Health Organization (WHO) and U. S. Public Health Service (USPHS) Malaria Advisors and the Director of the South East Asia Treaty Organization (SEATO) Medical Research Laboratory and his staff concerned with malaria research. In the field, the team members were accompanied by NMEP, PHS, and in some instances, WHO Country Personnel. After the review was concluded meetings were held with His Excellency, the Minister of Health, the Director and Headquarters Staff of the NMEP, the WHO Country Advisor, and the Director, Chief Medical Officer, and Malaria Advisory Staff of the U. S. Agency for International Development (USAID) Overseas Mission to Thailand. At these meetings the tentative conclusions reached by the team were presented, subject to such modification in detail as might be indicated after examination in depth, in Atlanta, of the mass of data accumulated during the review.

The sections of this report which deal with Regions 2, 3 and 4 have been compiled respectively by Drs. John Mueller, Marc LaForce and David Holden. Dr. William Chin compiled the

sections on chloroquine resistance and on Zone Pakchong in Region 1. Mrs. Ladene Newton, Statistician of the Evaluation Section of NCDC/MEP has given valuable advice on the collation and presentation of data.

At Appendix III are extracts from the report on the present status of entomology in the NMEP by David D. Bonnet, Ph.D., Chief of the Training Section, MEP/NCDC. His report was made at the request of the USPHS Chief Malaria Advisor in Thailand with the concurrence of the Under Secretary of State for Public Health and it is complementary to this review.

ACKNOWLEDGEMENTS

The Team is privileged to place on record its appreciation of the assistance given by all in Thailand with whom they came in contact in the course of the review. The Minister of Health and the Deputy Under Secretary of State for Public Health who is also Director of the NMEP gave generously of their time for discussion. The personnel working in the National Program in all areas of Thailand with whom we came in contact were most helpful and cooperative. The members of the WHO and USPHS Country Advisory Staffs gave all possible assistance as did the Director of the USAID Mission and those of his staff who were concerned with the arrangments for the review. Individual Team members are greatly indebted to the USPHS Country and Regional advisors and to the PCV's assigned to regions who accompanied them on their field trips and helped with the collection and collation of data. The Team is also very appreciative of the work of those in the NCDC/MEP in Atlanta who were responsible for the very complicated travel arrangements to and from Thailand and for secretarial assistance in the completion of the report.

CONCLUSIONS

A. CURRENT STATUS OF MALARIA IN THAILAND

1. The API and SPR data in randomly selected districts of Thailand show that after two years of comprehensive spray cover using DDT, malaria transmission has not yet been interrupted.

2. In certain rural areas in consolidation the incidence of malaria recorded is currently well above the level accepted for consolidation. This is due both to (a) a recrudescence of malaria in areas, such as the Chiangmai Demonstration Project areas, which have been successfully sprayed in the past and (b) the discovery of malaria transmission in areas previously thought to be non-malarious and placed directly into a consolidation phase for surveillance. An example of this is Samkhok in Region 5.

3. There are problem areas of high incidence of malaria in districts under attack supported by ACD surveillance and in districts in consolidation. These are held to be due either to the outdoor biting habits of Anopheles balabacensis and possible other vectors, or to "imported" infections contracted in areas not under spray cover. There is good evidence in certain of the districts surveyed that there is a concentration of malaria infections in adult age groups with males predominately affected; these infections are apparently related to the occupations of the individuals, e.g., farming in newly cleared hill forest areas, lumbering, rubber tapping, and tin mining.

4. Chloroquine-resistant strains of Plasmodium falciparum present qualitative and quantitative problems of immediate importance. In particular, field research into the relationship of this resistance to the present regimens of presumptive and radical treatment is urgent.

B. SPRAYING OPERATIONS

1. Spray cover was comprehensive in all areas visited. There was, however, little entomological data available to measure the effect on the vector populations.

2. There is no current information on the quality and duration of the DDT deposits in houses, which can be used to guide the timing and frequency of spray cycles. At present, these are determined empirically.

3. In certain districts it was possible to examine the relationship between the degree of intensity of DDT house spraying, including increased dosage of DDT per capita, and the levels of API's and SPR's recorded for those districts over the past 3 years. There was no correlation established and the degree of intensity of spraying was apparently not significantly related to the upward or downward movement of these two indices.

4. Dr. Bonnet, in his report on the status of entomology in the Thailand NMEP, has drawn attention to the need for field investigations to establish when and where transmission occurs. This need is fully endorsed by the team, as all the spraying and malariometric data available to it underline the necessity for operational research into this fundamental facet of the epidemiology.

5. The team has reached these conclusions in full awareness of the fact that there have been only two successive years of comprehensive spray cover of the areas under attack. On the other hand, there is a long history of control operations in Thailand, using DDT as a residual spray, without insecticide-resistant vectors appearing. When this is related to the circumstances of continuing transmission in areas under intensive spray cover, there is obviously a need now for an early review of the effectiveness of currently used house spraying techniques. It is important that this review should in no way prejudice the current intensity of spraying, but complement it by checking chemical, spray application, and vector reduction effectiveness.

C. RELIABILITY OF COMMUNICATION OF DATA AND ITS PRESENTATION

1. In every area of the country assessed there were errors in the transcription and communication of data. Transcription from forms used in the field to sector, zone and regional records, was generally inconsistent. In communicating the recorded data from sector to zone to region, the overall errors between sector records and regional records examined ranged from 7% to over 40%.

2. Calculations of incidence and rates were made generally at the regional offices where the major part of the presentation and interpretation of the data was undertaken. However, these data were not readily available to the zones and it was rare to find a zone office where ABER's, API's and SPR's were followed district by district. There is thus a serious lack of communication and interpretation of the processed data to those who are responsible at the operational levels in zones and sectors for the eradication activities in the field.

3. In some districts the graphic and tabular presentation of data in zone and sector offices appeared to be only imperfectly understood. While great efforts have been made by the headquarters of the NMEP to ensure uniformity in the presentation of data by charts, tables, graphs and maps, which will define clearly the progress towards eradication, in most areas visited this clarity has not been achieved. More emphasis on the training of zone and sector personnel in this aspect of the work is desirable as is more frequent checking by regional and national supervisors of the assessment and presentation of data at the zone and sector levels.

D. SURVEILLANCE NETWORK

The weakest part of the eradication project organization at the present time is the surveillance network, particularly through active case detection in areas under attack or in consolidation. There are several factors responsible for this condition:

(a) the difficulty in recruiting and in retaining the services of house visitors.

(b) the present system of classification of "imported" and "indigenous" cases.

(c) the long delays between the reporting of a positive slide and the radical treatment of the individual concerned.

(d) unduly heavy case loads resulting from the premature application of ACD surveillance to areas of high incidence of malaria without a corresponding increase in the personnel to the level necessary to ensure early and effective radical treatment, focal spraying, blood surveys and follow-up.

(e) the lack of a conscious effort on the part of supervisors to ensure that there is no age group or sex bias in slide taking in the populations under surveillance.

E. LABORATORY SERVICES

1. Generally speaking, the laboratory work is effective and the system of cross-checking is good. The timing of collection and transport of slides to laboratories requires a review aimed at the avoidance of backlogs and to ensure a steady flow of material to the laboratories throughout the month.

2. There is an unsatisfactory quota of poor blood smears coming into the laboratories and although the organization to correct this is established, it is not being utilized. To some extent this is balanced by the microscopists becoming proficient in reading defective or poorly processed slides.

3. The data examined support the conclusion that there is at present an overall efficiency of better than 99% in determining slide positivity. However, the percentage of false negative slides, while not necessarily prejudicial to the present stage of the eradication project, is far too high if large areas of Thailand are to be placed in consolidation.

4. Poor microscopists with records of substantial margins of errors do not appear to receive the personal supervision and further training they need. While the system of cross checking is

effective, it should be regarded rather as an indicator of weak areas that need correction by closer personal supervision and further training of individuals than merely for the simple detection of errors.

F. SUPERVISION

1. There was considerable variation in the effectiveness of supervision and the requirements laid down in project regulations were not observed consistently. In some areas, despite manifest inadequacies, little was being done to correct them.

2. Many of the inadequacies in supervision appear to be due to a lack of scheduling of the itineraries of supervisors working at national, regional and zone levels. With consistent and regular supervision at all levels in the Project, many of the activities in need of improvement would benefit materially. The team concluded that many of the squad chiefs did not know what was expected of them and no sustained effort had been made to ensure that they did know.

3. It was obvious to the team that where the Sector Chief was competent and industrious there were seldom noticeable operational deficiencies. Wherever this was not the case, the shortcomings were reflected throughout the Sector Chief's sphere of influence. Because of their key role, the selection and training of Sector Chiefs and the close monitoring thereafter of their activities in the field are of fundamental importance to the Project as a whole.

G. EPIDEMIOLOGIC ACTIVITIES

1. Despite long periods of comprehensive DDT spray cover in certain problem areas of Thailand, continuing high rates of malaria transmission persist.

2. There is good factual evidence that the highest incidence of malaria in certain problem areas is in the males aged 10 to 39. This is apparently related to occupations which expose this group to vectors with outdoor biting habits. The actual areas and mechanics of transmission of malaria to this sector of the population are undefined.

3. There is an urgent need for epidemiological and entomological operational research to be carried out in the field in these problem areas to define the places and circumstances of transmission. Only in this way can the currently used techniques be evaluated and modified to ensure steady progress towards eradication.

4. Until these problems have been elucidated, it would be dangerous and unjustified to relax in any way the current measures in force in the NMEP. Meantime, while the problems are being studied, the immediate objective should be higher operational efficiency in the surveillance network entailing more logical deployment of personnel for ACD, radical treatment, follow-up, blood surveys and focal attack measures as required by the 1965 Plan of Operations.

BACKGROUND TO THE REVIEW

A. GENERAL

Thailand has an area of 200,234 square miles (518,606 square kilometers) with an estimated population of 32,205,612 at the end of 1966. Of this total some 88 percent are rural dwelling and engage in rice farming, jute farming, vegetable and fruit growing, logging operations in the forested foothills and, in the south, rubber planting and tin mining. A high proportion of the urban population is concentrated in Bangkok and Dhonburi.

Thailand is bounded on the northwest and west by a mountain range running from north to south and along which runs the border with Burma. To the northeast and east is Laos, the Mekong River forming the boundary between the two countries. Cambodia and the gulf of Thailand form the major part of the southern boundary, while on the west of the Gulf the narrow Thai peninsula runs south to the border with Malaysia.

In the north of Thailand parallel ranges of mountains and forested foothills run north and south with large river systems lying between these ranges and draining through two extensive alluvial plains which are the main rice growing sections of the country. To the west is the Chao Phya river complex which, as it runs south to the Gulf, constitutes a major water transport system interlaced with canals. On the eastern side the rivers intersecting the other plain drain to the Mekong River.

The Thai peninsula also has two plains in the southern portion, separated by a chain of hills running north and south. The larger plain to the east lies on the Gulf while the smaller one to the west has its coast on the Andaman Sea.

Thailand lies within the monsoon belt and the rainy season lasts from May to October. Then follows a generally cool dry period which lasts until February. Between March and May hot dry conditions prevail until the southwest monsoon breaks. On the peninsula however the above pattern is considerably modified, and the climate is generally much milder. The following table extracted from the Plan of Operations gives details of the relevant climatic conditions in five MEP Regions:

TABLE 1*
SHOWING CLIMATIC SITUATION BY OPERATIONAL REGION

Region	Geographical Location	Rainfall		Temperature Centigrade		Humidity Percent		Months of Rainfall
		days	mm. Rain	Min.	Max.	Min.	Max.	
I	Central (Upper)	89	1224	15.7	33.4	23.8	98.4	May-Oct.
II	Northern	115	1350	13.5	34.6	21.2	98.2	May-Oct.
III	Northeastern	108	1447	14.0	36.0	23.2	98.4	April-Nov.
	(West)	104	2249					
IV	Southern			21.6	32.3	45.4	98.6	April-Dec.
	(East)	146	2088					
V	Central (Lower)	100	1629	19.5	31.6	36.0	98.2	May-Oct.

All average figures have been derived from ten years data (1953-1962) and represented in tabular form for different localities in each region.

* Source - Thailand National Malaria Eradication Project Plan of Operations, 1965.

Internally, communications have improved vastly in recent years and a growing network of paved roads has greatly facilitated motor transport and movements of large numbers of people. In the central plain, with Bangkok as the focal point, there is a large volume of small vessel river traffic on the network of klongs or canals which are also used for irrigation and drainage.

The opening up of communications and the rapid natural growth of the rural population has given rise to large socio-economic development projects, particularly to the north and east within which health protection plans are being formulated and coordinated with on-going programs. From the point of view of malaria eradication, however, it is the uncoordinated and often illegal breaking of new ground by farmers developing small holdings on the fringes of the foothills or the making of new clearings in the forests that are presenting a major problem.

B. ADMINISTRATIVE STRUCTURE

The National Malaria Eradication Project, with its headquarters in Bangkok, is a Division of the Ministry of Public Health and the Director of the Project is also an Under Secretary of State for Public Health. A National Malaria Eradication Board advises the Minister on policy, financing and on the coordination of effort among all departments of government which may be concerned with the program. In addition there is a Program Planning Committee composed of officials of the Ministry of Public Health, WHO and USPHS. Its responsibilities include a continuing technical and evaluative review of the Project and assistance with the preparation of material on policy issues for the consideration of the Malaria Eradication Board.

For the purposes of the NMEP, Thailand is divided into five Regions, each with a Regional Malariologist in charge who has the executive responsibility for field operations and who is accountable to the Director of the NMEP at the National Headquarters. Regions are divided into zones numbering between 5 and 7 according to population density and distribution. Zones are divided into 10 to 12 sectors each with a population of between 80,000 and 100,000. In each sector there is an appropriate number of spraying and surveillance squad chiefs who are responsible to the sector chief for their operational activities. Sector chiefs are directly responsible to zone chiefs and it is at the zone and sector levels that the executive detail of spraying and and surveillance operations is actively operational.

Supporting the Regional organization are Supply and Transport Services, Health Education and Public Relations Sections, a Training Section, and a Laboratory Service with zone, region and central laboratories staffed by trained microscopists working under the supervision of chief microscopists.

The program is a Royal Thai Government (RTG) project conducted under the responsibility of the Government with the technical advice of WHO and USAID. Advisors assigned by WHO and USPHS act as chief technical advisors to the RTG. The spraying and surveillance operations are conducted according to the internationally observed criteria developed by WHO. For the full detail of the administrative organization the Plan of Operations of July 1965 should be consulted.

C. REQUIREMENTS FOR SPRAYING OPERATIONS

Both spraying and surveillance operations are dependent for success on continuing accurate geographical reconnaissance. This is the responsibility of surveillance workers, squad chiefs and sector chiefs, who, in the course of their routine spraying or surveillance operations, are required to keep maps, house cards, and itineraries up to date. The erection of many new houses, temporary shelters and animal sheds throughout the year, as well as increases in and movements of population, make this continuing reconnaissance an onerous but essential task to insure success.

To quote the 1965 Plan of Operations, "the spraying of residual insecticides in all human and animal dwellings" is accepted by the NMEP as the principal method of interrupting malaria transmission. It is also stated that "chemoprophylactic measures" may be used to supplement spraying in areas where "extra-domiciliary transmission is proved or suspected."

Spraying with 2 grams technical DDT per square meter at one cycle each year is being applied to areas with stable populations; in areas with unstable populations or with transmission problems, 2 cycles are being used, the dosage of the second application being 1 gm of technical DDT per square meter. The spray is applied to the inside of all human and animal shelters up to a height of 3 meters, to all eaves and roofed verandas, to all under surfaces of floors on stilts

and the roofs of unwalled structures in isolated areas. Follow-up teams are available to spray missed houses, new structures, and other unsprayed vector resting places. The first spraying operations are generally timed to precede the peak of malaria transmission and are carried out in March to May. When there is a second cycle this is timed for July to September; both cycles should be completed in 90 days. Barrier spraying is carried out in the periphery of the municipalities.

In view of the status of malaria eradication programs in neighboring countries, all the contiguous Thailand border areas are remaining in the attack phase until such time as circumstances permit movement into a consolidation phase.

In areas under spray cover when malaria survey rates show that the child parasite rate has been reduced below 2%, surveillance covering the whole population of these areas is instituted. Where natural malaria endemicity is below 0.01% or the API has been reduced to or below that level by spraying and surveillance, then spraying may be withdrawn and surveillance only maintained to detect and treat parasite carriers. However, where foci of infection are detected in this way, focal spraying is called for.

That these spraying procedures are being substantially implemented was clear. In fact, in many areas the outsides of dwellings and shelters had also been sprayed. In certain problem areas, such as Pakchong, a third cycle of spraying had been introduced and the yearly rotation was: first cycle - 1 gm square meter; second cycle - coinciding with the timing of one cycle spraying elsewhere, 2 gm per square meter; third cycle 1 gm per square meter.

D. REQUIREMENTS FOR SURVEILLANCE

As the surveillance organization is considered in some detail later in this review, the requirements in the 1965 Plan of Operations, particularly for active case detection (ACD) and passive case detection (PCD), are reproduced *in toto* in Appendix IV.

Surveillance during the early stages of the attack phase is through malariometric surveys directed at the measurement of the gross incidence of malaria in the relevant community. These surveys should be so conducted as to ensure comparable annual measurements which are made either at the end of the malaria transmission season or, in an area of perennial transmission, 8 to 10 months after the start of the first spraying cycle of the year. Once the infant parasite rate has fallen to below 1% and the child parasite rate, in children 2-9 years of age, has fallen below 2% as a result of house spraying, then the more precise measurements of active and passive case detection are introduced; this can be expected to happen usually during the third year of the attack phase. Case detection thereafter has to be meticulously applied and maintained if eradication is not to be prejudiced gravely, particularly during the consolidation phase when spray cover has been withdrawn.

Three aspects of the practice of active and passive case detection in Thailand require explanatory comment here as they have a bearing on problems defined later.

First, in active case detection presumptive treatment is generally given, when the blood film is taken, in two doses each of 300 mgm of chloroquine base and 25 mgms of pyrimethamine rather than in the single dose of 600 mgms of chloroquine base and 50 mgms of pyrimethamine laid down in the Plan. These dosages are adjusted generally for children according to age and body weight. This divergence from the Plan has arisen because of complaints of gastric discomfort or disturbance following the single larger dose; the first half of the dosage is now given under supervision when the blood film is taken and the person concerned is advised to take the second half at the next meal. There is thus no guarantee that this second dose is taken and further comment on this aspect is made in the section dealing with chloroquine resistance.

The second comment is in respect to the classification of malaria cases according to the presumed source of infection. The classification between "imported" and "indigenous" cases is being made frequently in Thailand on a village or canton basis. As the boundaries of these administrative entities are adjusted largely for political and administrative reasons they do not necessarily have any geographical or epidemiological relevance to the problem of malaria transmission in what are epidemiologically homogenous communities. Thus, an "imported" case in Village A may have contracted the infection in Village B only a short distance away and should be

classified epidemiologically as "indigenous." Because it is at the sector chief level that the responsibility for action lies when a positive blood examination has been reported to his office, once a case is classified as "imported" it becomes technically the responsibility of a sector chief in another area to initiate action. This situation gives rise to confusion and lack of action.

The third point of importance is that, in certain well-defined instances, the case load resulting from the initiation of ACD and PCD, sometimes before it is technically warranted, has proved to be far beyond the capacity of the personnel and other resources of the sector concerned. Accordingly, only the readily located "indigenous" cases tend to be investigated. This situation is particularly critical in the areas already in consolidation and the urgent necessity to review this aspect of the Plan is discussed later.

EPIDEMIOLOGY OF MALARIA IN THAILAND

A. HISTORICAL

Accurate statistics of the incidence of malaria in Thailand as a whole are scanty prior to 1949. When the Department of Health was established in 1918 between 40,000 and 50,000 deaths from malaria are said to have been reported annually. During the period 1946-1950 malaria ranked first among the 10 principal causes of death with the following death rates per 100,000 of population:

TABLE 2
Malaria Death Rates

Years	1946	1947	1948	1949	1950
Deaths per 100,000	271.7	299.9	250.7	210.5	194.9

Population - 17,422,689 (Census) 18,662,000 (Estimate)

The first malaria control unit was founded in Chiangmai in 1930, and in 1931 two additional units were established in the Central and Northeastern regions of the country respectively. These units conducted malaria surveys, limited treatment programs and public information, the latter being particularly related to self protection in the home.

In 1934 a Malaria Section in the Division of Infectious Disease Control of the Department of Public Health was established. Experimental work on larviciding using Paris Green was then in progress as well as experiments in the water management techniques of controlling anopheline breeding. In 1935, Dr. Luang Bhayung Vejjasasto demonstrated plasmodial sporozoites in specimens of A. minimus dissected in Southern Thailand and thus, for the first time, demonstrated its capacity as a vector of malaria in Thailand. In 1936 the Chiangmai Malaria Control Unit dealt successfully with a localized epidemic of malaria by cleaning and flushing ditches, larviciding and the distribution of atabrine.

During the war years that followed, Thailand suffered numerous malaria epidemics in many provinces and it is reported that deaths from malaria averaged more than 50,000 annually.

In 1943 the Malaria Section of the Division of Infectious Disease Control became a separate Division within the Department of Health. The headquarters of the Division was in Bangkok with five regional headquarters in the North, Northeast, Central, West Coastal and Southern Regions. The major function was the distribution of antimalarial drugs to war veterans and farmers with the primary objective of increasing food crop production through the suppression of malaria infections.

In 1949 a WHO/UNICEF Malaria Control Demonstration Project was established in Chiangmai. The District of Sarapee was chosen for the demonstration of the effectiveness of residual insecticides applied in the home as a measure of malaria control. Prespraying surveys of the area gave precise data regarding the prevalence of malaria, the role of A. minimus as the only vector of importance in the area at that time and documented its biting and house-resting habits. Spleen, parasite and infant parasite rates prior to control measures in 1949 are shown below:

TABLE 3
Spleen and Parasite Rates in 1949;
Chiangmai and Lampoon Provinces Before Control

Province	District	Spleen Rate	Parasite Rate	Infant Parasite Rate
Chiangmai				
	Sarapee	63.84	47.26	29.50
	Hangdong	88.80	32.21	17.03
	Chiangmai	60.95	28.02	19.35
	Doi Saked	61.80	72.30	18.08
	Sankampang	37.50	43.18	18.96
	Sansai	69.70	57.48	31.48
	Sanpatong	67.60	39.53	7.69
	Mae Rim	72.35	24.90	20.30
	Mae Tang	73.62	29.71	29.10
	Chomthong	56.34	24.90	30.30
	Chieng dao	64.46	28.49	18.30
	Phrao	56.48	21.0	?
	Hod	40.00	19.63	20.80
	Fang	62.77	32.47	50.00
Lampoon				
	Lampoon	55.35	34.15	17.50
	Pasang & Banhong	67.80	24.10	19.14
	Mae ta	66.86	30.43	21.54
	Lee	36.65	24.85	13.70

Similar indices are not readily available for other areas of Thailand at that time but subsequent malariometric surveys indicate that the situation in the hyperendemic foothills areas of the country as a whole was very similar. Luang and Griffith in 1953 recorded the "spleen and blood examinations and fever censuses have demonstrated malaria rates in large areas in every region of Thailand. In uncontrolled malaria areas, spleen rates among school children regularly exceed 50% and frequently are over 75%, and parasite rates are usually 25% or more in such groups. High endemicity (with spleen rates of 25% to 50% in children) is general in large areas in every region of Thailand and hyperendemicity (with spleen rates exceeding 50% and frequently much higher) is common in the malarious areas. Parasite rates generally exceed 15% and range up to more than 50% in the most malarious districts."

Blood films examined in uncontrolled districts during the 1952 malaria survey showed the following slide positivity rates:

TABLE 4
1952 Malariometric Survey

Region:	North	N.E.	Central	South
Films examined:	21,502	6,818	17,135	3,201
Films positive:	4,735	1,150	3,423	495
Percent positive:	22.0	16.9	22.0	15.5
Percent *P. falciparum*:	69.0	57.0	95.5	88.7
Percent *P. vivax*	29.9	48.5	4.5	11.3
Percent *P. malariae*	1.1	0.5	0.0	0.0

There is ample evidence, therefore, that prior to 1955 which is the year the eradication concept began to develop, Thailand was generally a malarious country with the areas of hyperendemicity largely related to the foothills. The rice cultivation and coastal areas were presumed to be largely hypoendemic if not entirely non-malarious.

During the late 1940's the striking success of DDT as a residual insecticide prompted WHO to offer to interested governments assistance in the form of Malaria Control Demonstration Projects. The Government of Thailand quickly took advantage of this offer and the 1949-1951 Chiangmai Malaria Control Demonstration Project resulted. Its striking success in the control of malaria has been well documented in the relevant WHO SEA/MAL 1 report of 5 Frebruary 1953 (Sambasivan, Ugan, Bhatia & Vimol). The following results were recorded:

TABLE 5
Malariometric Surveys
Chiangmai Malaria Control Demonstration Project

	November 1949	November 1951
Spleen Rate	63.8%	12.8%
Parasite Rate	47.3%	0.8%
Infant Parasite Rate	27.9%	0.0%
Fever Morbidity	50.5/1000	2.1/1000

Accordingly, the Government of Thailand, with WHO/UNICEF/AID support, rapidly expanded its control program until in 1965 some 25,513,293 persons were being protected by house spraying and surveillance. The progress of this expanded program is shown below:

TABLE 6
EXPANSION OF MALARIA PROGRAM 1949-1966

Year	Malaria Deaths	1/ Rate	Population Protected Spraying	Surveillance	Total
1949	38,046	210.5	-		-
1950 2/	35,819	195.0	77,503	-	77,503
1951 3/	34,225	183.5	581,312	-	581,312
1952 4/	29,115	153.5	1,570,249	-	1,570,249
1953	21,451	111.4	3,016,808	63,727	3,080,535
1954	16,473	84.2	4,266,442	414,776	4,681,218
1955	14,520	73.1	5,618,856	1,636,192	7,255,048
1956	13,076	57.4	7,364,176	3,052,107	10,416,283
1957	19,577	45.5	7,640,891	4,383,810	12,024,701
1958	9,230	39.0	7,833,290	4,551,871	12,385,161
1959	8,443	33.1	6,988,095	7,124,294	14,112,389
1960	7,664	30.0	6,321,576	6,246,036	12,567,612
1961	6,636	24.5	5,350,414 5/	4,782,582	10,132,996
1962 6/	6,693	24.1	9,434,879	5,226,544	14,661,423
1963	6,488	22.8	13,323,827	5,520,097	18,843,924
1964	5,287	18.2	15,982,285	8,000,136 7/	23,982,421
1965	4,394 10/	-	18,731,776	6,592,056 8/	25,323,832 9/
1966	-	-	19,084,758 11/	6,428,537	25,513,293

1/ Mortality rate per 100,000 population
2/ Thai Government assisted by WHO and UNICEF
3/ Thai Government assisted by WHO, UNICEF and AID
4/ Thai Government assisted by AID only, 1952-1961
5/ Of this number, 1,438,817 persons were protected by second cycle spraying
6/ Thai Government assisted by AID and WHO
7/ 4,002,733 under consolidation phase and 3,997,403 under preparatory phase
8/ 3,969,678 under consolidation phase and 2,622,377 under preparatory phase
9/ Does not include municipal areas
10/ Does not include Nakhornphanom the whole year
Nakornpathom last 7 months
Chumphorn last month
Satool last 3 months
Songkhla last 4 months
11/ Does not include 2 districts in Satool and Phang-nga.

The decision that the objective of the antimalarial program should become eradication rather than control was taken in 1955. This entailed considerable reorganization as well as a re-orientation of attitudes and the more meticulous application of surveillance techniques. Plannig to this end proceeded over a number of years and in June 1965 the Plan of Operations of the National Malaria Eradication Project of Thailand was signed by representatives of the Royal Thai Government and WHO.

In effect from 1961 onward, the Thailand antimalaria program was in the transition from control to eradication. In 1963 it became evident that, subject to budgetary provision and adequate logistic support, tentative plans could be made for the comprehensive coverage by house spraying of the defined malarious areas of the whole country. It was only in 1965 however that this coverage was satisfactorily achieved.

B. THE SITUATION AT DECEMBER 31, 1966

At the end of 1966, except for an area of the central plain with a population of 1,700,000 people in the preparatory phase, the whole of Thailand was either in the attack or the consolidation phase of the Malaria Eradication Project.

The areas in the attack phase contain 22.9 million people of which 10.8 million are being protected by two cycles of spraying. Active Case Detection is being applied to a population of 14.6 million in the areas under the attack phase while the remainder are still under surveillance through annual malariometric surveys.

The areas in consolidation contain a population of 6.5 million of which 4.7 million are protected by surveillance through ACD; the remainder live in the metropolitan areas of Bangkok and Dhonburi and other municipalities where surveillance is not in force as transmission is not believed to occur in these urban areas and the population is thus not at risk of malaria.

The available measure of the progress of the eradication program is inevitably based on the surveillance activities which depend fundamentally on good slide taking, staining techniques and microscopy. These aspects are discussed in some detail later in this report. Speaking generally, when consideration is given to the magnitude of the operation and the expected range of human error in techniques necessarily depending on an uniform performance of individuals, the laboratory procedures as applied now are adequate to the present stage of the Eradication Project. Nevertheless, the prime measurement of success in interrupting transmission must be the Annual Parasite Incidence based on an adequate Annual Blood Examination Rate.

During the period of comprehensive spray cover (1965/1966) and for the year before (1964), the following are the recorded data:

TABLE 7

Phase and Region	1964		1965		1966	
	ABER	API	ABER	API	ABER	API
Consolidation						
Region I	8.0	2.9	9.1	3.3	8.4	2.2
Region II	10.9	0.9	11.4	1.5	13.1	1.2
Region IV	6.0	2.5	10.0	3.3	8.9	1.2
Attack						
Region I	10.8	9.5	9.6	8.9	10.9	5.4
Region II	14.6	8.2	14.6	6.2	15.0	4.2
Region III	12.8	3.9	11.1	3.3	11.6	1.5
Region IV	9.5	4.7	12.0	6.3	11.6	5.5
Region V	-	-	8.8	3.8	12.0	2.2
Preparatory						
Region IV	4.8	2.2	4.2	1.1	10.6	1.0

Examination of numerous spot maps at the zone offices visited by the members of the team and of the supporting data indicate clearly a diffuse zonal distribution of malaria with some clustering of cases in certain villages. Although these spot maps are prepared according to the point of origin of the positive blood slide and not according to the locus of infection, nevertheless it is obvious that malaria transmission is still occurring diffusely throughout the malarious areas of Thailand investigated, despite comprehensive and apparently effective house spraying with DDT.

C. CURRENT CONCEPTS

In an evaluation such as this it is important to express the currently held views on the epidemiology of malaria and to indicate how closely the data support them. Therefore, it is desirable to record certain facts and views widely held in Thailand as a part of the statement of the current situation.

The effective vectors of malaria throughout Thailand are known to be A. minimus, A. balabacensis and, additionally in parts of the south, A. maculatus. It is possible that A. sundaicus may also play a role in transmission in the coastal areas under conditions of high density of this vector occurring in close association with groups of parasite carriers. Recently in central Thailand, a short distance north of Bangkok, A. aconitus has been incriminated as a vector in an area previously believed to be non-malarious. A general outline of the species and distribution of anophelines in Thailand is in Dr. Bonnet's Report at Appendix III.

The highest incidence of transmission of malaria is believed to occur largely in the foothill areas away from the main centers of population and from the village homes of permanent residence which are under comprehensive spray cover. This is presumed to be due to the movements of farmers, migrant farm laborers, lumber workers, rubber tappers and tin miners who acquire their infections when away from home and living in temporary shelters in the fields or forests, or while at work in plantations or tin mining. As the whole family, or members of the family, often accompany the worker, so family infections also occur away from home. When these infected individuals return to their permanent houses transmission does not take place to uninfected susceptible families living in surrounding houses because of effective DDT spray coverage.

These extra domiciliary infections are thought to be predominantly due to A. balabacensis which, owing to its largely exogenous and exophagous habits is not as vulnerable to attack using residual insecticides as are other vectors. Accordingly, A. balabacensis is held responsible for the continuing high rates of malaria transmission in the newly cleared or temporarily occupied forest fringes and in the plantations, although A. minimus may also be an active biter out of doors in certain situations.

So far no resistance to DDT has been found among anophelines in Thailand which are either known or suspected vectors of malaria. Spray cover is comprehensive in the areas in the attack phase and as the vectors are fully susceptible to DDT, it is concluded that other factors are responsible for the continuing transmission of malaria. These factors are believed to be the migratory habits of certain sectors of the population which expose them to infections in areas where DDT cover cannot be satisfactorily provided either because of outdoor living and sleeping or because of the outdoor biting habits of certain vectors. Nevertheless even under such circumstances, there are some with firmly held convictions that an increased efficiency of spraying operations based on continuing geographical reconnaissance and supplemented by ACD and radical treatment are the ultimate answers to the problem.

The undoubted presence of chloroquine resistant strains of P. falciparum is accepted as a contributory factor with pockets of high incidence of these strains recognized in certain problem areas. Again, as the vectors are still fully susceptible to DDT this is regarded by some as not being unduly alarming as long as effective DDT spray cover can be maintained. In this connection particularly, increasing quantities of DDT per capita are being applied and, in some districts, a third cycle of spraying has been instituted.

METHODS

This evaluation was concerned primarily with the methodology in use to measure the current status of malaria in Thailand and the progress towards eradication. Before starting the field oriented surveys in depth in three of the NMEP Regions, generally uniform methods of approach were developed as far as was possible beforehand. These were concerned with the reliability of laboratory diagnostic techniques, the accuracy of recording, transmission, interpretation and utilization of data, the effectiveness of spraying operations, the efficacy of the surveillance network, the success of the remedial measures associated with surveillance, and with supervision. When the Team members arrived at the relevant Regional Headquarters, the areas to be surveyed at zone and sector levels were selected at random.

In addition to the surveys in depth at zone and sector levels in three of the Regions, the quality and quantity of chloroquine resistant falciparum malaria was studied in some detail both from hospital records and from ACD records. The epidemiology of malaria in areas of high transmission was also studied, particularly in Zone Pakchong in Region I, and in problem areas in the other four Regions. The itinerary at Appendix II indicates the scope of the review.

REGION 1 SURVEY - ZONE PAKCHONG

For some years Zone Pakchong has been regarded as a problem area by the personnel of the National Program. This Zone is a focus of continuing high malaria transmission and of high prevalence of chloroquine resistant falciparum malaria. Accordingly one member of the Review Team devoted four days in the Zone to a more detailed study of these problems.

A. BACKGROUND

Originally part of the Korat Zone of Region 1, when the Malaria Eradication Program was reorganized in 1963, Pakchong, because of its special problems, was then designated as a separate zone. It consists of parts of the two Provinces of Nakhon Ratchasima and Saraburi and Figure 1 shows the distribution of cantons and their grouping into sectors. The Zone is characterized by dense forests and hilly areas with extensive and recent clearing of land for farming in the plains between the hills and in the foothills. The population of 115,123 persons is highly mobile. There are two basic patterns to these movements.

(a) Residents indigenous to the Zone periodically leave permanent homes to work in the fields or in the forests. Here they live in temporary shelters for varying periods of time. Frequently an entire family may accompany the head of the household and live in temporary shelter until they return to the permanent village home.

(b) During the planting and harvesting seasons there is a temporary influx of farm laborers from outside Pakchong. Although this movement is regular and its occurrence well known, there is little detail available regarding its extent, routes of migration, and areas of origin.

Because of continuing high transmission of malaria, the entire Pakchong Zone has been under 3 cycle DDT spray cover since January 1966. In the first cycle of the year, DDT is applied in a dosage of 1 gm per square meter; in the second cycle the dosage is 2 gm per square meter; and in the third cycle again 1 gm per square meter. Only scanty information is available regarding the anopheline vectors but it is believed that both Anopheles minimus and Anopheles balabacensis are significant vectors with the latter possibly more important in view of its outdoor biting habits.

Table 1 shows the personnel roster for the Pakchong Zone and it will be seen that sector 3 has the largest staff assigned. This is because of the geographic site of this sector and its density of population.

TABLE 1
PERSONNEL IN SURVEILLANCE AND SPRAYING OPERATIONS AT ZONE 7, DISTRICTS PAKCHONG AND KAENKOI

	Spraying Operations						Surveillance					
					Mop-up Team							
Sectors	Sector Chief	Assist Sector Chief	Perm. Squad Chief	Perm. Spray-men	Squad Chief	Spray-men	Assist. Sector Chief	Squad Chief	House Visitor	Special Teams	Reserve House Visitors	Total
1	1	1	4	12	1	2	1	3	13	2	2	42
2	1	1	3	9	1	2	1	4	11	2	1	36
3	1	1	4	12	1	2	1	6	14	2	3	47
4	1	1	3	99	1	2	1	4	13	2	1	38
Total	4	4	14	42	4	8	4	17	51	8	7	163

B. CURRENT STATUS OF MALARIA ERADICATION IN ZONE PAKCHONG

The active case detection data for the period 1964-1966 are presented in Table 2. Although the API for 1966 is half the value of the 1964 Index, the 1966 figure of 52.7/1000 is still high after a full three years of comprehensive house spraying with DDT. During the same period, the percent distribution of the species of malaria encountered has not changed significantly and P. falciparum remains dominant. (Table 3)

TABLE 2
ACTIVE CASE DETECTION DATA, 1964-1966

	Pakchong (Sectors 1 & 2)			Kaengkhon (Sectors 3 & 4)			Total		
	1964	1965	1966	1964	1965	1966	1964	1965	1966
Population	56,874	70,131	73,053	58,249	64,309	71,576	115,123	134,440	144,629
Total Slides	31,041	39,709	19,742	12,470	30.120	25,286	43,511	69,829	45,028
Positive	9,106	9,910	3,059	3,305	7,583	4,565	12,411	17,483	7,624
% Positive	29.34	24.96	15.49	26.50	25.18	18.05	28.52	25.04	16.93
ABER	54.58	56.62	27.02	21.41	46.84	35.33	37.80	51.94	31.13
API	160.10	141.30	41.98	56.70	117.90	63.80	107.80	130.00	52.70

TABLE 3
Percent Distribution of Malaria Species in Zone Pakchong

	1964		1965		1966	
	No.	Percent	No.	Percent	No.	Percent
P. falciparum	13,521	85.4%	20,339	84.6%	12,007	82.2%
P. vivax	3,109	13.3%	3,439	14.3%	2,412	16.5%
P. malariae	-	-	-	-	-	-
Mixed p.f. & p.v.	133	0.8%	246	1.0%	109	1.3%

The age and sex distribution of blood slides positive for malaria as recorded on MS8 forms for representative cantons in Zone Pakchong are shown in Table 4; those for admissions to the nearby Prabuddhabat Hospital are shown in Table 5.

TABLE 5
PERCENTAGE DISTRIBUTION BY AGE AND SEX OF PATIENTS WITH DIAGNOSIS OF MALARIA
PRADUDDHABAT HOSPITAL

Age	Sex	% Population of Thailand	December 1-11, 1965	December 1-27, 1966
-1	F	1.2	1.8	-
	M	1.2	1.8	-
1-4	F	6.8	5.4	6.8
	M	7.0	7.1	9.1
5-9	F	7.5	1.8	6.8
	M	7.7	3.6	6.8
10-20	F	10.5	3.6	9.1
	M	10.8	25.0	13.6
20+	F	23.9	16.1	9.1
	M	23.5	33.9	38.6
ALL	F	50.2	28.6	31.8
	M	49.8	71.4	68.2

TABLE 4
PERCENTAGE DISTRIBUTION BY AGE AND SEX OF ACD SMEARS AND POSITIVE CASES FROM MS-8
SEPT., OCT., NOV., 1966*

Village, Canton:				#2, Musi**	#4, Kahmpran		#1, Hinson		#1, Chanthuk	
Age In Years	Sex	% Population of Thailand*	Percent Smears	Percent Cases	Percent Smears	Percent Cases	Percent Smears	Percent Cases	Percent Smears	Percent Cases
< 1	F	1.2	-	3.3	0.4	0.4	-	-	0.5	1.0
	M	1.2	-	0.8	0.1	0.4	-	2.4	0.6	0.5
1-4	F	6.8	5.8	8.1	2.6	2.0	1.8	-	5.1	5.2
	M	7.0	4.9	10.6	3.4	4.8	1.8	2.4	5.9	3.1
5-9	F	7.5	10.7	7 3	6.8	6.7	12.3	7.1	8.5	3.6
	M	7.7	7.8	12.2	5.7	7.1	14.1	7.1	7.8	6.8
10-19	F	10.5	17.5	14.6	10.3	11.1	9.8	14.3	11.8	10.4
	M	10.8	3.9	12.2	19.7	26.2	23.3	33.3	10.3	21.4
> 20	F	23.9	15 5	7.3	18.1	13.5	17.8	19.0	22.8	13.5
	M	23.5	34.0	23.6	32.9	27.8	19.0	14.3	26.6	34.4
ALL	F	50.2	49.5	40.7	38.2	33.7	41.7	40.5	48 8	33.9
	M	49.8	50.5	59.3	61.8	66.3	58.3	59.5	51.2	66.1

* Thailand population as of April 15, 1960 from United Nations Demographic Yearbook, 1965
** Cases in #2 Musi are for all of 1966.

Although the age and sex distribution for ACD blood slides actually collected in the four villages represented in Table 4 suggest that there is a definite sampling bias, the fact remains that the MS8 records represent positive blood slides taken from persons within the villages who are, or who have been, actually sick with fever. Further, the data from the hospital admissions represent individual cases of malaria serious enough to gain admission to the hospital. Within these limitations the data indicate that, in this problem area, malaria infection occurs most commonly in those over 10 years of age and that males are more prone to infection than females; infants aged under one year are least at risk of infection. As a comparison, admission records of malaria patients during December 1965 and 1966 indicated the same general trend as that shown by the MS8 records.

C. SPRAYING OPERATIONS

A summary of house spraying operations for 1966 is shown in Table 6:

TABLE 6

SPRAYING OPERATIONS

Spraying records - cycle 1, 1966 (1 gm sq/m)
District Pakchong (Sectors 1 & 2)

No. villages		33
Houses sprayed (total/incomplete)		15,140/1,153
Missed houses (locked/refused)		435/514
Percent missed		6.2%
No. occupants under spray coverage		74,146
No. occupants per house		4.8
No. sq. meters sprayed:	Total	5,472,543
	per house	361.4
	per capita	73.8
No. kg (75%) DDT		
kg used		9,395.5
gm per house		620.5
gm per capita		126.7
Dosage gm/sq. meter		1.27
No. sprayman days		2.127
No. of houses/sprayman/day		7.1
Sq. meter sprayed/sprayman/day		1,849.9

During 1966, the entire zone has been under three cycle spraying. From an operational viewpoint spraying has been judged as good and effective. Visits to 25 houses in villages 1, 4 and 7 of Canton Musi confirmed the fact that spraying is being accomplished with thoroughness and adequate coverage.

The major problem in the spraying operation is the great difficulty in locating new houses. This is due to construction of temporary huts in relatively inaccessible sites surrounded by tracts of dense vegetation which make the location of and access to new buildings very difficult, although relatively adjacent to motor tracks.

D. SURVEILLANCE NETWORK

This is carried out by house visitors who visit their designated areas twice each month according to a predetermined itinerary. During the first cycle of visits, ACD is their function; during the second cycle radical treatment is given to individuals who have yielded positive blood smears. Attempts are also make during this second cycle to locate houses either newly built or in construction. Unfortunately, there is a very rapid turnover of house visitors, due to resignations or dismissals, which necessitates frequent changes of itineraries. Inevitably, this has an adverse influence on the follow-up of individuals requiring radical treatment. Further, supervision of house visitors by squad chiefs is poor. This was confirmed by the inspection of house cards in 25 houses in three different villages in Canton Musi and checking the number of visits made in the previous three months. (Table 7)

TABLE 7
House Card Inspection (Canton Musi)

	Three visits	Two visits	One visit	Not visited	Total houses
No. houses visited	4	7	9	5	25

E. LABORATORY SERVICES

The zone laboratory in Pakchong has been in operation since 1960. At present, there are five microscopists with an average of 3.4 years of experience. In 1966, 65,086 smears were examined. The average number of smears examined per month is 5,422 with an average backlog of 516 smears per month. The number of unusable smears (dirty, broken) in 1966 was recorded as 189. The number of smears sent to Regional or Project Labs for cross-checking consist of:

14,180 negatives of which 44 were found to be positive;
5,489 positives of which 26 were found to be negative; and
19 had incorrect species diagnosis.

The staining technique used is the Walker modification of the Giemsa stain. Smears are placed individually on a trough and then flooded with stain. Following staining, smears are lifted out individually and rinsed in buffer. This method, while it may conserve stain, predisposes to dirty smears due to adherence of stain precipitate. It is also time-consuming in that slides are handled individually rather then collectively as in staining racks.

The buffer is made up in the Zone laboratories with phosphate salts issued from the Regional Laboratory. These are then weighed by zone personnel at the town pharmacy and made up according to the formulae found in the Project Manual for the preparation of stock buffer reagents. No attention is paid to the pH of the buffer since the laboratory has no way of determining pH.

Twenty smears taken by three different house visitors and by a PCD post technician were picked at random and examined.

5 smears had less than 1WBC/2-3 oil fields
4 smears were grossly contaminated with bacteria and stain precipitate
8 smears had poor differentiation of stain
3 smears were good.

In nine of the 20 smears, therefore, diagnosis normally would be extremely difficult if not impossible

It should be noted, however, that in spite of the general inadequacies found in the stained smears, the number of incorrectly diagnosed smears as judged by cross-checking is small.

F. ASSESSMENT OF ZONE PAKCHONG

1. Despite comprehensive spray coverage the transmission of malaria has not been interrupted and the API for 1966 of 52,9/1000 is still very high.

2. It is not precisely known where this transmission is taking place and through which anopheline vector. Study of the data available in Table 4 indicates that there appears to be an excess of incidence in the 10-20 years age group and that males predominate over females.

3 Judged on the data available in MS-8 records for Zone Pakchong there is a generally unsatisfactory response to the treatment of falciparum malaria with chloroquine. The highest incidence of unsatisfactory response is in Canton Musi.

4. The basic requirements of surveillance through ACD in the Zone are not being met and the follow-up of individuals with positive blood smears is gravely inadequate for eradication purposes.

5. While the diagnostic work of the Zone laboratories is adequate at this time, a 0.3% error in false negative slides requires correction before surveillance can be regarded as satisfactory for the move into a phase of consolidation.

6. The effect of population movements on the incidence of malaria has not been determined. This aspect of the problem needs to be investigated and precisely defined.

G. CONCLUSIONS

Intensive field reserach is required in Pakchong to define:

(a) the areas where transmission is taking place

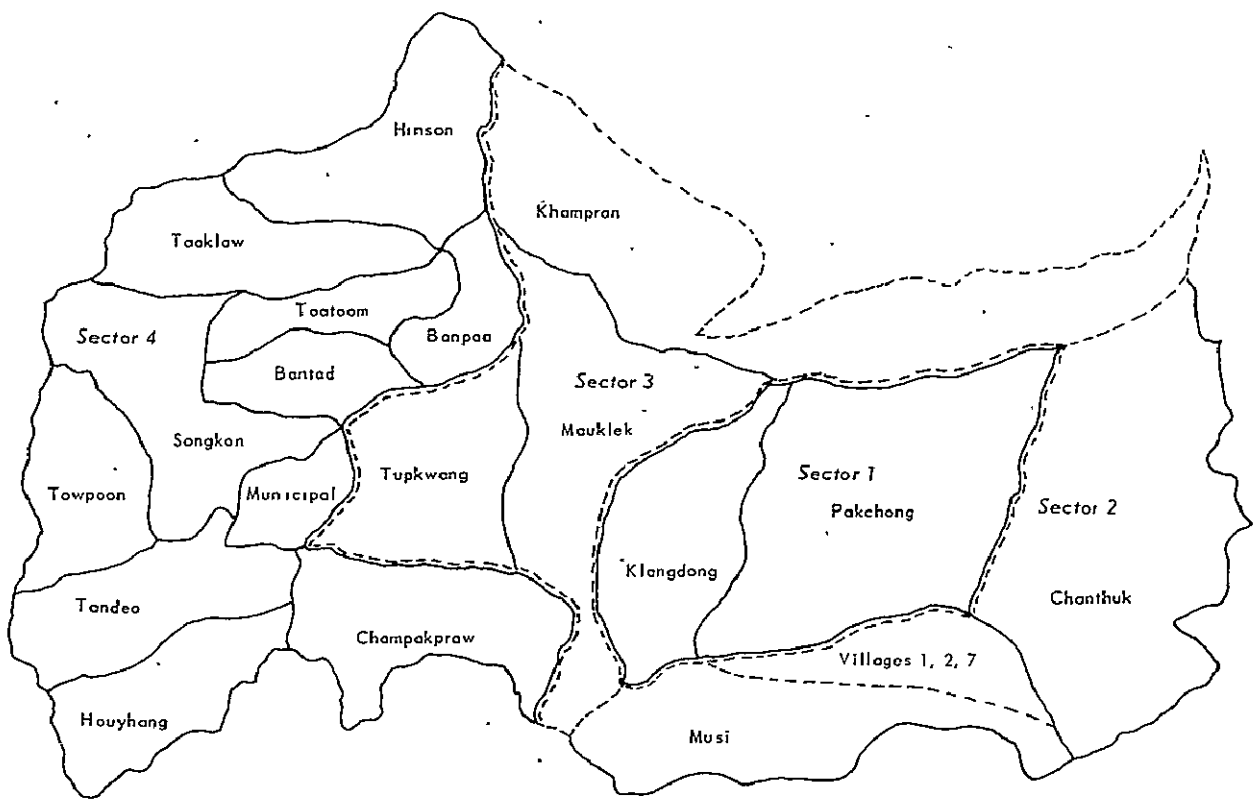
(b) the influence of population movements on the persistence of transmission

(c) the vector responsible and its relevant breeding and biting habits.

(d) the influence of chloroquine resistance on the persistence of transmission of P. falciparum despite comprehensive residual insecticide cover of dwelling places.

FIGURE 1

REGION 1 – ZONE PAKCHONG



CHLOROQUINE-RESISTANT FALCIPARUM MALARIA IN THAILAND

A. BACKGROUND

In 1962, Professor Tranakchit Harinasuta demonstrated for the first time the existence of chloroquine-resistant falciparum malaria in Southeast Asia. She reported 48 cases of falciparum malaria in Thailand treated with the conventional 1.5 gm. chloroquine base, nine of which were not cured. In these nine patients recurrence of patent parasitemia was observed 2-3 weeks after completion of therapy. The following year Young and co-worker reported on the JHK strain of Plasmodium falciparum isolated from a patient who contracted his infection in Thailand. Study of this strain in non-immune volunteers confirmed Harinasuta's finding, and also showed the parasite to be resistant to all other synthetic antimalarials but curable with quinine.

In 1965, when Harinasuta and co-workers reported a cure rate of only 2 of 42 patients with falciparum malaria given the conventional 1.5 gm chloroquine base, they offered additional evidence as to the extent of the chloroquine-resistance problem in Thailand. Of the 40 patients whose infections were not cured, 12 exhibited a partial temporary effect and 28 exhibited complete temporary effect with parasitemia becoming subpatent, but recurring on an average of 12.9 days following completion of treatment. While these studies have established the fact that chloroquine-resistant falciparum malaria is present in Thailand, little is known concerning its prevalence and distribution.

In view of the findings cited, it was deemed necessary to investigate the significance of this problem in terms of its effect on the malaria eradication program.

B. METHODS

Three Regional Offices (1, 2, and 3) in Phrabubbhabat, Chiangmai, and Khon Kaen respectively, were visited. Of these, only Region 1 and specifically Zone Pakchong were studied in any detail. The major portion of the data used for this purpose was taken from MS8 forms. The only ACD records used were those where the time interval between presumptive treatment and subsequent follow-up was 40 days or less. In view of the known duration of action of 600 mg dose of chloroquine base, it was decided that a longer time interval would make it impossible to rule out reinfections.

C. PRESUMPTIVE TREATMENT

In general, the presumptive treatment given is chloroquine, 600 mg base, and pyrimethamine, 50 mg, in two equally divided doses. In Zone Pakchong, pyrimethamine was replaced by primaquine, 30 mg. The doses for children were adjusted according to age. The following information was recorded from MS8 records: Age, sex of patient, date initial smear taken, presumptive treatment rendered and results of subsequent follow-ups.

In addition, and when available, hospital records of patients admitted for malaria were reviewed.

The results of presumptive treatment as shown in MS8 records for 1966 are indicated in Table 1.

TABLE 1
RESULTS OF PRESUMPTIVE TREATMENT (1966)

Source of MS-8 records		Total Reviewed Cases	Unsat. response to presump. treat. No. Cases	% Cases	Time interval (days) between initial smear and radical treatment average (range)
Region II (Chiang Mai)					
Zone 1					
Sectors 2,3,4,10		160	12	7.5%	22.4 (11-40)
Region III (Khon Kaen)					
Zone 1					
Sectors 6,7,9		132	53	40.0%	14.5 (2-32)
Region IV (Songkhla)					
Zone 2					
Sector 3		95	38	44.6%	-
Region I	Villages				
Zone Pakchong	1	62	44	71.0%	17.9 (15-39)
Canton Musi	2	33	32	97.0%	18.9 (15-27)
Sector 2	3	7	1	14.0%	16
	4	23	9	35.0%	15.6 (11-30)
	5	27	9	33.3%	24 (19-30)
	6	18	7	39.0%	16.3 (15-17)
	7	9	8	88.0%	19.2 (17-27)
Sector 4, Canton Khanpran, Village 4		473	272	57.5%	14.2 (11-30)
Canton Toaklow Village 2-8		39	18	46.1%	18.7 (8-30)
Canton Klongdong Village 2		95	31	32.6%	16 (8-34)
Canton Chanthuck		73	14	19.2%	23.3 (10-40)
Canton Pakchong Village 11		81	26	32.0%	17 (5-20)

The results indicate the Chiangmai has the lowest percentage of unsatisfactory response to presumptive treatment (7.5%). The percentage for Regions 3 and 4 in those localities specified was 40% and 44.6% respectively.

In contrast to these findings, the data from Zone Pakchong were of considerable interest. In village 2 of Canton Musi, of 33 people given presumptive treatment, 32 cases were still parasite positive during the first follow-up.

D. RADICAL TREATMENT

Data on the results of radical treatment, as recorded in the MS8 forms, were generally not utilized because of inconsistent and oftentime lack of adequate follow-up. In general, the follow-up of positive cases after radical treatment was poor. The area with the most diligent follow-up was Region 3 where, of the 53 cases still positive after presumptive treatment, records of follow-up after radical treatment were available for only 30 cases. Of these 30, the first follow-up, approximately one month after radical treatment, showed 28 cases still positive, 8 showed trophozoites alone and 20 had both trophozoites and gametocytes. Follow-up records from other areas were too grossly incomplete to be of value in an assessment of the effectiveness of radical treatment.

E. OTHER OBSERVATIONS

In 1965, in Region 2, Chiangmai, the Regional Malariologist investigated seven cases of falciparum malaria in close proximity to the Regional Office. These seven patients had recently returned from the Pakchong area and radical treatment with chloroquine plus primaquine was instituted and blood smears taken daily. Each of the seven cases showed varying responses to chloroquine therapy but none were cured and all eventually required quinine sulfate to terminate the infection.

In May 1966, in Region 4 in district Sadao of the province of Songkhla, a mass blood survey was undertaken in Village 12 of Thungmoh Canton. The population of the village was 325 and a total of 306 smears were taken. Eighty-six smears (28.1%) were positive, of which 84.9% were P. falciparum. Radical treatment was instituted for all positive cases. Approximately one month later, a SEATO team resurveyed the same village and found essentially the same percent of positive cases. This village was under comprehensive spray coverage with DDT.

The provincial hospital in Prabuddhabat (Region 1) was visited. Malaria is still the most important medical problem of this area, accounting for approximately 10% of all hospital admissions. It was estimated by the hospital staff that 40% of the patients treated with the standard 1.5 gm dose of chloroquine base failed to show a clearance of the parasitemia within five days after completion of treatment.

In a 1966 study, 34 cases treated with 1.5 gm chloroquine base were closely followed. Thirty-five percent did not show an adequate clinical response and were febrile for four days or more after initial therapy; 25% showed frank resistance as measured by no clearance of parasitaemia one week after therapy. In February 1967, in Canton Musi, the multi-purpose team from Pakchong conducted special surveys in Villages 1 and 2. Positive cases of falciparum malaria were given radical treatment with chloroquine and smears were collected again two weeks later. During this first follow-up nine out of eleven and eight out of nine smears were still positive in Villages 1 and 2 respectively.

F. ASSESSMENT

1. In most instances, because of a lack of adequate follow-up, indisputable evidence documenting the extent and distribution of chloroquine-resistant falciparum malaria in Thailand is extremely meager.

2. Available data indicate however that strains of chloroquine-resistant falciparum malaria in Thailand are widespread and that, in certain localized areas, its prevalence may approach 100%.

3. Failures of treatment of falciparum malaria with chloroquine are undoubtedly responsible in certain areas for the perpetuation, increase, and in some instances the extension of the human reservoir of infection.

4. This facet of the problem of eradication must be a matter for the utmost concern and warrants early and most intensive study.

G. CONCLUSIONS

1. More precise data regarding the extent of chloroquine resistance in each Region are required urgently through special surveys in areas of high transmission of malaria.

2. The present organization and practice of Active Case Detection requires a review aimed at ensuring comprehensive and meticulous application of the criteria laid down in the Plan of Operations.

3. The present practice of using pyrimethamine as part of the presumptive treatment with chloroquine has no scientific justification and should be reviewed.

4. In individuals yielding positive smears one month after radical treatment with chloroquine and primaquine, alternative therapy shoud be employed to achieve a radical cure of infection.

5. The most effective alternative therapy for fieldduse would be a single combined oral dose of sulphorthomidine, 1 gm, plus pyrimethamine, 50 mgm. Evidence indicates that this treatment will yield cure rates in excess of 90%; in the 10% of failures that may be anticipated, quinine, 10 grains 3x/day for five days, should be utilized and the sulphorthomidine/pyrimethamine not repeated. This is in order to prevent a build-up of resistance by parasites to the combination treatment with drugs which readily induce resistance when given singly in repeated doses.

REGION 2 SURVEY

INTRODUCTION

Region 2 is in Northwestern Thailand. It is bordered by Burma on the north and west, Laos, and Region 3 on the north and east and Region 1 to the south. The north of Region 2 is comprised of heavily forested mountains running north and south. Lumbering is carried out in these forests and farming in the valleys. As one passes south and eastward, the mountains diminish and a flat fertile plain predominates. Here farming of rice, tobacco, and vegetable crops are the major forms of employment.

The Region has a total estimated population of 5,596,095 of which 1,700,801 live in consolidation phase areas. In 1967, 16 of the 95 districts will be in the attack phase under malarometric survey surveillance, 55 in the attack phase under ACD surveillance, and 24 in the consolidation phase.

It was in Region 2 that the Chiangmai Malaria Control Demonstration Project of 1949 to 1951 proved so strikingly successful. When the control program became an eradication program the demonstration area was placed directly into a consolidation phase.

The data presented and the observations that follow are based on a field survey made from March 10, 1966 to March 25, 1966. The survey was made predominantly at zone and sector levels after a preliminary study of data at the Regional Headquarters at Chiangmai.

A. CURRENT STATUS OF MALARIA ERADICATION

In Region 2 the annual parasite incidence (API) and the annual blood examination rate (ABER) were tabulated by district at the Regional Office for 68 districts for the years 1965 and 1966, and for 55 districts for 1964, 1965, 1966. ACD, PCD and mass blood survey positives were all included in the calculation of the API regardless of the eradication phase designation of the district. Where the data were available for the purpose, the slide positivity rate (SPR) was also calculated (Table 1).

Of the 55 districts for which data were available for 1964, 1965 and 1966, only 23 had a decrease in API in both 1965 and 1966. In only three of these 55 districts was there a reduction by a half or more in both 1965 and 1966. Of the 66 districts for which data were available for both 1965 and 1966, in only 11 was the API for 1966 half or less than half of that for 1965.

It is apparent that these data support the conclusion that the malaria eradication measures applied in 1964, 1965 and 1966 have not yet achieved an interruption of transmission of malaria in the majority of the districts of Region 2 which were under ACD surveillance.

B. SPRAYING OPERATIONS

Spraying operations were evaluated by examining the data compiled by the National Malaria Eradication Project and by spot-checks in the field.

It can be seen from Table 2 that certain general trends have presented over the last three years. First, the missed-house rate has increased; second, the grams of DDT per capita have increased; third, sprayman-days have increased.

An attempt was made to determine if there was any correlation between changes in API's and in three parameters of spraying; the missed house rate, the incomplete house rate, and the grams per capita of DDT applied. For this purpose changes in missed house rates, incompleted house rates and grams per capita of DDT were correlated with changes in API's. The results of this correlation are shown in Table 3.

TABLE 1
ABER, API AND SPR BY DISTRICTS
REGION 2 - 1964-1966

PROVINCE	DISTRICT	1966 POP.	ABER 1964	ABER 1965	ABER 1966	API 1964	API 1965	API 1966	SPR 1964	SPR 1965	SPR 1966
CHIENGMAI	Muang	43,631	13.56	14.95	10.56	1.15	1.38	1.31	0.15	0.15	0.092
	Sarapee										
	Hangdong	42,196	14.55	13.29	13.78	0.63	0.09	0.14	0.37	0.70	0.71
	Sansai	52,864	14.74	13.59	13.3	0.81	0.22	0.11	0.25	0.16	0.22
	Maerim	38.662	14.66	11.42	12.01	0.87	0.05	0.31	0.59	0.048	0.39
	Doisaket	43,320	16.16	14.23	12.1	1.33	0.62	0.58	0.56	0.42	0.19
	Sankampang	68,312	14.9	12.16	15.41	1.45	0.22	0.32	0.56	0.13	0.40
	Maetang	47,992	18.31	18.73	17.2	1.1	0.68	0.75	0.59	0.58	0.27
	Prao	35,362	18.21	15.74	15.47	0.91	0.33	0.45	0.45	0.19	0.22
	Samoneng	9,773	28.71	21.79	18.56	0.74	0.31	0.4	0.26	0.07	0.37
	Chomthong	61,337	14.51	13.66	16.08	2.31	0.47	0.62	0.45	0.33	0.13
	Maechaem	22,061	19.24	17.82	20.63	2.82	1.00	0.63	0.16	0.54	0.90
	Chiengdao	35,225		22.31	14.49		1.27	0.67	1.36	0.45	0.20
	Fang	124,959		13.03	8.71		0.23	0.18	.13	0.16	0.56
	Hod										
	Om Koi										
	Sanpatong	85,772	12.07	17.78	10.2	1.39	0.87	0.22			
LAMPOON	Muang	95,009	10.46	13.99	14.86	0.6	0.4	0.21	.39		0.06
	Pasang	61,285	11.8	13.2	13.3	0.86	0.76	0.83	0.61		0.44
	Maethar	21,004	19.4	14.76	13.18	5.05	5.15	2.27	0.22		0.13
	Banhong	29,703	12.22	11.35	12.91	1.95	1.08	1.13	0.13		0.77
	Lee	44,043			14.43			7.44			4.1
LAMPANG	Wangnua	31,048		13.14	15.05		1.44	0.84		1.07	0.55
	Jaehom	62,879	16.03	10.46	13.61	4.19	5.42	2.08	2.4	5.2	1.53
	Ngao	36,794		19.56	14.59		16.56	5.44		7.8	3.65
	Muang	127,677		10.29	10.5		4.6	2.79		3.6	2.28
	Hang-chat	35,638		9.32	11.59		1.04	0.95		1.12	0.79
	Koh-kha	82,939		14.80	14.63		5.11	2.11		3.01	1.4
	Mae-thah	59,962	19.31	15.09	11.96	10.12	7.47	2.56	4.3	4.1	2.12
	Sob-prab	21,388	19.01	15.75	15.31	11.45	9.95	7.76	5.4	6.0	5.06
	Thoen	38,390	18.41	13.08	16.6	23.41	10.66	7.42	10.1	6.0	4.41
	Mae-Prik	12,494		14.79	16.22		7.02	8.16		4.5	5.03

TABLE 1 - CONTINUED

PROVINCE	DISTRICT	1966 POP.	ABER 1964	ABER 1965	ABER 1966	API 1964	API 1965	API 1966	SPR 1964	SPR 1965	SPR 1966
CHIENGRAI	Wiengpapao	38,909	10.53	7.81	5.36	0.28	0.25	0.1	0.26	0.28	0.15
	Muang	134,443		12.16	23.05		0.52	1.47		0.39	0.62
	Maechai	27,004	7.72	7.98	11.16	0.63	0.25	0.78	0.79	0.25	0.69
	Maechan	80,346			13.3			0.82			0.61
	Maesruay	39,673		15.93	9.9		0.55	0.55		0.35	0.55
	Maesai	44,294			17.09			0.7			0.27
	Payao	90,182	10.27	12.92	13.12	3.6	1.56	1.08	2.4	0.99	0.65
	Dokkamtai	58,228	12.76	15.01	14.37	1.99	2.3	1.36	1.1	6.04	0.78
	Parn	118,118	8.02	7.35	12.11	0.9	0.41	0.34	0.85	0.51	0.27
	Chiengsaen										
	Chiengkhong										
	Thoeng										
	Chieng kham										
	Chunsub										
	Pong										
PRAE	Rongkwang	45,298		29.31	13.78		6.04	3.75		2.08	2.61
	Song	42,454		33.98	23.94		5.69	4.19		1.60	1.72
	Muang	66,564		23.81	27.52		25.11	22.61		2.71	2.68
	Soong-men	61,364	24.54	24.54	21.10	18.31	19.39	12.63	7.13	7.36	5.55
	Denchai	22,855	18.26	23.12	20.47	18.43	20.35	13.48	9.37	7.71	6.09
	Long	37,554	26.83	17.84	13.39	23.75	11.35	7.75	7.97	5.18	4.28
	Wang-chin	17,754	27.46	13.94	37.28	31.76	10.93	10.59	10.0	4.58	2.40
UTTARADIT	Faktha										
	Nampad										
	Thapla	19,425	27.27	26.23	23.72	44.73	35.96	20.64	13.6	11.5	7.66
	Muang	68,648	9.3	16.88	11.31	11.94	9.19	6.94	11.8	4.58	5.78
	Lablae	35,579	21.96	18.52	11.85	10.44	7.28	6.79	4.26	3.45	5.59
	Tron	34,311	14.66	12.55	14.56	14.85	5.67	8.42	9.68	4.40	5.68
	Pichai	41,619	13.22	13.93	13.04	1.51	0.58	0.84	1.07	0.415	0.65

TABLE 1 - CONTINUED

PROVINCE	DISTRICT	1966 POP.	ABER 1964	ABER 1965	ABER 1966	API 1964	API 1965	API 1966	SPR 1964	SPR 1965	SPR 1966
PITSANULOKE	Nakornthai										
	Wangthong	63,862	15.63	19.19	20.1	9.55	7.22	6.48	4.76	2.75	2.93
	Watbot	20,147	28.04	21.7	23.04	14.44	5.08	5.41	2.88	1.65	1.43
	Bangrakam	47,854	11.62	22.31	17.65	0.09	0.74	0.36	.731	2.46	.17
	Muang	80,606	12.37	11.34	24.26	2.58	4.05	4.06	1.08	0.59	0.18
	Bangkrathum	39,897	21.23	20.26	18.4	0.59	0.16	0.33	0.27	0.06	0.17
	Prompiram	47,592	21.17	17.91	18.51	0.79	0.41	0.15	0.33	0.16	0.08
SUKHOTHAI	Muang	54,573	15.1	15.89	21.95	1.2	1.72	0.95	.58	0.82	0.37
	Kirimas	24,588	24.37	16.33	13.29	6.68	3.22	1.09	1.25	0.87	0.68
	Srisamrong	43,736	20.05	17.01	16.44	0.28	0.5	0.27	.123	0.28	0.167
	Sawankaloke	57,487	18.09	18.19	19.56	0.38	0.6	0.59	0.183	0.29	0.24
	Kongkrailas	28,775	18.52	18.25	18.93	0.37	0.3	0.18	0.181	0.15	0.095
	Bandanlanhoi	10,675	30.93	13.74	22.53	18.89	7.13	3.75	3.41	3.32	1.29
	Thungsaliem	26,654	13.39	26.58	26.8	4.06	3.01	2.4	2.81	1.12	1.04
	Srisatcha-nalai	49,500	18.43	20.44	20.28	18.18	10.48	7.52	7.46	3.80	3.08
PICHIT	Bangmulnak	55,460	15.47	11.5	12.51	2.23	5.74	2.88	1.12	3.22	1.78
	Phothale	66,530	15.04	11.76	11.09	0.77	2.41	2.01	0.50	1.71	1.57
	Tapanhin	91,689	15.66	14.87	13.14	3.16	15.00	7.8	0.77	2.78	1.68
	Muang	101,792	10.71	11.57	9.61	1.45	2.26	1.5	0.88	1.56	0.97
	Sam-ngarm	41.579	7.9	8.77	7.80	0.48	0.88	0.60	0.50	0.85	0.523
PETCHBOON	Lomsak										
	Lomkao										
	Muang										
	Chondaen	38,834	31.75	27.34	47.18	67.71	62.05	52.48	13.7	18.76	7.35
	Nongphai										
	Wichienburi										

MAP NO. 1

REGION 2
API BY DISTRICT 1966

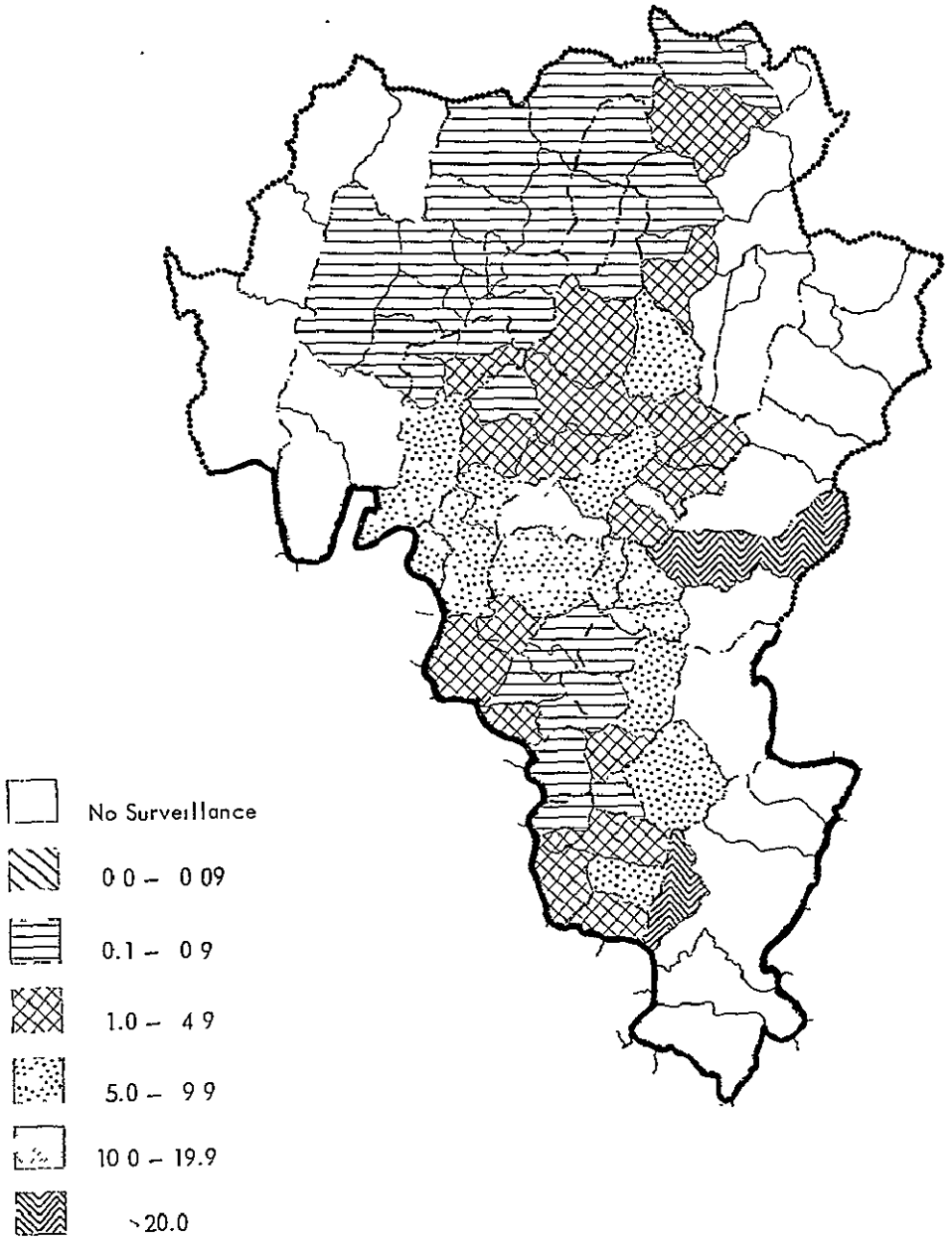


TABLE 2
SPRAYING ACTIVITIES (1st Cycle) 1964-1966

	1964	1965	1966
Villages	4,367	4,318	4,390
Houses Sprayed	583,098	588,641/13,476	620,958/23,116
Houses Missed	19,995	10,134/24,295	9,131/29,259
% Houses Missed	3.3	5.8	6.1
No. of Occupants in Sprayed Houses	3,140,885	3,198,959	3,363,759
No. Occupants Per House	5.3	5.4	5.4
No. Sq. Meters	149,340,513	152,793,614	186,102,538
Sprayed	256.1	259.5	299.7
Per House	47.5	47.7	55.3
75% DDT			
K. gm used	411,611.0	437,615.0	547,450.5
Gm. Per House	705.9	743.4	881.6
Gm. Per Capita	131.0	136.7	162.7
Gm. Per Sq. Meter	2.02	2.10	2.17
No. Sprayman Days	67,412	70,414	82,823
No. Of House/Sprayman Days	8.6	8.3	7.4
Sqm. Sprayed/Day	2,215.3	2,169.9	2,246.9

TABLE 3
CORRELATION BETWEEN SPRAYING PARAMETERS AND API'S

	Missed-House Rate		Grams of DDT Per Capita		Incompleted House Rate	
	Increase	Decrease	Increase	Decrease	Increase	Decrease
API Increase	11	4	12	2	7	3
API Decrease	25	7	27	13	17	8

There was no correlation between increased efficiency of spray operations, as measured by these three parameters, and a reduction in the API. These findings would support a contention that the variation in the intensity of spraying operations occurring in 1965 and 1966 had no measurable effect on the incidence of malaria.

Spot-checks in the field in Region 2 indicated that all but the most recently constructed houses showed evidence of spraying and that, when sprayed, the coverage was good. It was noted, however, that not infrequently certain surfaces had been wiped or had been rubbed clean of visible DDT deposits.

TABLE 4

MISSED HOUSE RATE, INCOMPLETE HOUSE RATE AND DDT GRAMS PER CAPITA FOR REGION 2
1964, 1965 and 1966

Province	District	% Houses Missed			% Houses Incomp. Sprayed			Grams Per Capita		
		1964	1965	1966	1964	1965	1966	1964	1965	1966
Chiangmai	Muang									
	Sarapee									
	Hangdong									
	Sansai									
	Maerim									
	Doisaket									
	Sankampang									
	Maetang	3.5	4.6	4.7		1.1	1.6	134.6	139.4	171.0
	Prao	2.0	3.1	2.6		0.5	0.9	147.0	135.8	221.6
	Samoeng	3.8	3.4	4.8		4.3	3.8	140.6	130.5	147.9
	Chomthong	0.9	2.4	3.0		0.4	0.4	143.2	140.1	151.8
	Maechaem	1.2	1.2	3.2		0.5	0	113.1	95.8	98.9
	Chiengdao	5.4	4.8	4.8		1.0	3.7	136.2	138.4	215.7
	Fang	4.9	5.9	7.3		5.5	7.0	141.8	143.4	166.2
	Hod	6.1	9.1	2.6		3.2	4.6	137.4	147.3	192.2
	Om Koi	6.0	5.4	5.2		0.8	0.8	110.7	111.6	98.5
	Sanpatong									
Lampoon	Muang									
	Pasang									
	Maethar	2.9	3.6	2.5		1.1	1.7	137.0	143.4	153.5
	Banhong	2.3	3.9	4.7		0.8	1.0	172.1	160.0	169.6
	Lee	7.3	17.0	17.2		1.8	2.1	142.2	128.4	179.7
Chiengrai	Wiengpapao	2.5	3.4	5.3		1.4	5.9	177.4	158.7	132.6
	Muang	0.96	4.1	8.3		3.2	5.6	132.0	132.6	167.0
	Maechan	2.8	5.1	7.8		2.8	5.7	134.3	131.3	174.3
	Maechai	1.9	7.5	9.1		0.7	5.0	148.1	114.3	175.3
	Maesruary	2.7	6.4	6.9		0.8	3.2	138.8	147.8	126.2
	Maesai	5.2	5.6	12.4		2.9	7.8	110.2	115.3	118.5
	Payao	1.8	3.3	5.5		1.1	1.6	132.3	132.3	200.9
	Dokkamtai	1.2	3.0	7.3		0.2	2.6	143.1	118.4	138.1
	Parn	3.9	5.8	4.9		0.2	0.3	128.0	118.7	233.9
	Chiengsaen	1.8	4.1	5.7		0.7	2.4	112.2	125.6	158.7
	Chiengkhong	1.4	7.4	4.6		0.3	1.6	116.8	113.5	154.4
	Thoeng	1.0	4.7	5.8		0.6	1.9	119.0	123.8	170.6
	Chieng Kham	5.5	3.4	3.6		0.6	0.4	125.4	129.4	200.3
	Chunsub									
	Pong	1.9	4.7	4.5		0.7	0.6	120.1	140.4	165.6

TABLE 4 - Continued

Province	District	% Houses Missed			% Houses Incomp. Sprayed			Grams Per Capita		
		1964	1965	1966	1964	1965	1966	1964	1965	1966
	S Joon		3.5			1.3			121.5	
Prae	Song	1.4	3.2	3.5			0.3	141.1	163.5	168.6
	Rongkwang	0.8	3.8	3.8		0.1	0.2	158.0	145.7	156.5
	Muang	5.4	5.5	8.8		1.8	3.5	157.4	156.9	212.7
	Soong-men	2:0	3.5	3.9		1.8	0.5	146.7	157.9	162.1
	Denchai	1.9	3.0	5.3		2.2	1.0	112.4	158.8	172.1
	Long	1.9	0.7	3.2		0.3	0.1	154.5	164.9	161.2
	Wang-chin	1.9	0.9	4.0		0.2	0.2	140.9	163.4	141.7
Petchboon	Lomkao	4.8	8.3	10.0		2.2	1.9	109.7	90.0	88.8
	Lomsak	5.8	11.0	5.4		3.8	2.6	121.7	118.4	117.5
	Chondaen	3.4	4.5	1.8		2.5	3.7	100.9	102.5	124.1
	Nongphai	0.6	4.7	3.3		0.7	2.3	110.9	98.0	140.5
	Muang	2.1	6.9	5.0		2.1	6.2	112.8	104.3	120.8
	Wichienburi	1.5	5.4	1.9		1.4	4.9	104.3	80.6	85.9
Nan	Thungchang	2.4	4.2	5.1		0.3	0.01	102.6	122.8	146.5
	Pua	1.6	2.3	5.9		0.2	0.3	87.3	109.1	134.0
	Thawangpha	2.2	2.9	5.7		0.2	0.1	121.4	129.8	140.2
	Muang	1.4	2.8	5.6		1.3	0.7	148.5	136.2	182.9
	Sa	0.5	2.8	4.0		0.6	0.6	136.6	126.8	168.9
	Na-noi	1.1	3.1	3.6		0.2	0.02	132.2	115.8	116.9
Pitsanuloke	Wangthong	1.5	4.9	3.5		1.9	5.4	127.0	134.0	179.8
	Nakornthai	4.3	8.0	1.6		1.4	2.4	138.7	117.2	181.6
	Watboad	4.6	1.7	11.7		15.7	26.4	114.4	112.5	158.6
	Prompiram									
	Muang									
	Bangkrathum									
Sukhothai	Srisamrong	5.9	5.7	10.5		4.4	6.7	155.0	121.8	162.9
	Thungsalien	7.3	7.0	9.8		1.3	5.7	156.1	115.3	132.6
	Bandanlanhoi	0.1	11.7	6.1		9.0	13.9	123.0	119.6	131.0
	Muang									
	Srisamrong									
	Sawankaloke									
	Kirimas									
	Kongkrilas									
Pichit	Muang									
	Sam-ngarm									
	Phothale									
	Bangmulak									
	Tapanhin									

C. RELIABILITY OF COMMUNICATION OF DATA AND DATA PRESENTATION

The flow and summarization of data from the house visitors and spraymen and its communication to the Region Office are vulnerable to clerical error. In an attempt to assess the the magnitude of the error, figures for spray data and slide collection were compared from region to zone and from zone to sector.

TABLE 5
COMMUNICATION OF DATA

Zone	to Sector	Number of Figures	Number Inconsistent	Per Cent Inconsistent
I	6	65	2	3.1%
II	10	186	2	1.1%
IV	5	100	55	55.0%
V	10	17	2	11.8%
V	*	12	3	25.0%
Total Zone to Sector		380	64	16.8%
Total Region to Zone		23	19	82.6%

*Sector number not recorded.

As can be seen in Table 5, the range of error is not only wide but, over all, is quite significant. The use of carbon paper in the preparation of multiple copy forms in some sectors largely eliminated all nonagreement and data from these forms were not included in this tabulation. The considerable gain in accuracy achieved by the use of carbon paper was accompanied by only a slight loss of legibility.

The presentation and interpretation of data so necessary to an assessment of progress was scanty in all but the Regional Office. API's and ABER's were calculated only by the Region, and the Zone and Sector offices uniformly did not have this data. Presentation of data in the Zone and Sector offices was largely limited to (1) annual spray data summaries, (2) house visitor's monthly slide production in relation to a 1% a month quota, (3) results of investigation and classification of cases by month, (4) number of slides produced and number of slides positive, graphed by month, (5) two maps on which cases were marked by colored pins representing epidemiologic classification. One map was for the preceding year and one for the current year's cases.

The wall chart showing cases and investigations by month did not correspond to the actual month's cases, because the columns designated "number of cases investigated" and "classification" contained a varying proportion of cases from previous months. The MS-7, from which this chart was derived, was tabulated in the same way and thus it was impossible to tell from either the chart or the MS-7 the actual number of new cases investigated for a month or a year or to determine the epidemiologic classification by month or year.

The graph of the number of slides taken and the number of slides positive was difficult to interpret and was interpreted erroneously not infrequently. On occasions, when questioned as to why the number of cases increased during a particular month, a sector chief would point to the increased number of slides taken, while it was apparent that the slide positivity rates had simultaneously increased. The addition of the slide positivity rate to the graph and the presentation of API data by graphs at the sector and zone office would, with little effort, greatly supplement the the presently sparse summarization of epidemiologic data at the operational level.

The use of pins in a map to designate cases is presumably designed to visualize with greater accuracy the precise locality in which transmission of malaria takes place. Current practices throughout Region 2 largely defeat this purpose. First, villages indicated by number on the map frequently contain hamlets scattered over a wide and often varied area; in one area visited, two hamlets showing positive cases in the one village were more than five kilometers apart. Although these hamlets are indicated on the map, almost invariably pins are placed in the village number rather than the particular hamlet in which transmission allegedly took place. Second, the practice of plotting the "imported X" case at the village where the case was discovered rather than the village at which transmission took place obscures the geographic pattern of transmission. When the "imported X" cases are a high proportion of total cases, and it is not unusual in some sectors for them to comprise 50% or more of the cases, the actual site of transmission may not be defined for the majority of cases. The same procedures are used at the zone offices.

D. SURVEILLANCE NETWORK

1. House Visitors Activities

(a) Coverage

The house visitors activities were evaluated by recording the number of slides taken either per village or per day of cycle each month. They were then assessed by calculating the number of days per cycle or number of villages in which the visitor took slides during at least 3/4 of the year. This gives an estimation of locality coverage. Temporal coverage was evaluated by calculating the number of months during which slides were taken on at least 3/4 of the days of the cycle or in at least 3/4 of the villages visited. Approximately half way through the evaluation, the basis of reviewing house visitor coverage was changed from a village basis to a day of cycle basis because of the increased sensitivity of the latter procedure.

The rates of coverage seen when a village basis is used for calculations are not comparable to those found when days of cycle are used. Deviations from 100% in the former represent a less complete coverage than identical deviations in the latter (Tables 6 and 7).

Using a criterion of 75% or less of coverage in either of the two categories as being adequate it will be seen that 6 out of 19 of the itineraries were inadequately covered during the year 1966.

(b) Reliability - Field checks of House Visitors

Unfortunately during the study in Region 2 a consistent means of evaluation of the work of house visitors in the field was hampered by the unavailability of certain forms, difficulty in

TABLE 6
ANALYSIS OF HOUSE VISITORS' SLIDE COLLECTIONS BY ITINERARY DAY

Zone	Sector	House Visitors Itinerary No.	No. of Days on Itinerary	# of Months for which Data was Available in 1966	No. of days W/ACD Slides for at least 3/4 of months	% of days in Itinerary W/ACD Slides for at least 3/4 of Months	% of house visiting cycles for which ACD slides were collected 3/4 of the days
4	5*	1-3	27	12	25	93%	82%
4	5*	1-2	27	11	26	96%	82%
4	5*	1-4	27	6	16	59%	75%
4	5*	1-1	27	10	13	48%	40%
5	9*	2-1	27	11	13	48%	40%
5	9*	2-2	27	11	9	33%	54%
Unident.	Unident.	Unident.	27	12	22	82%	83%
Unident.	Unident.	Unident.	27	12	27	100%	100%
Unident.	Unident.	Unident.	27	12	17	62%	58%

*All consolidation areas.

TABLE 7
ANALYSIS OF HOUSE VISITORS SLIDE COLLECTIONS BY VILLAGE

Zone	Sector	House Visitor Itinerary No.	No. of Villages	No. Villages with ACD Slides for at least 9 months of 1966	Percent of Villages with ACD Slides for at least 9 mos. of 1966
1	6	6-2-1	9	8	89%
1	6	6-2-2	15	12	80%
2	10	1	8	7	88%
2	10	2	7	7	100%
2	13	13-3-1	17	17	100%
2	13	13-3-2	11	11	100%
2	?	?	8	7	88%
3	7	7-2-2	9	9	100%
3	7	7-2-3	7	5	71%
3	7	7-2-4	9	8	89%

locating house visitors and the necessity to try out alternative approaches to discover the best method of evaluation. Because of this, only a small sample of any one measure of performance was obtained and accordingly no general conclusions can be drawn.

Of the 6 house visitors' current forms checked only 1 was entirely correct and up to date; a total of 12 mistakes or omissions was noted among the remainder. Of the slides and equipment of 6 house visitors checked, only 2 had clean slides; 4 had the other items of their equipment in order. Forms of 7 house visitors were checked for signatures indicating squad chief surveillance in the past 3 months; 3 had an unsatisfactory number of signatures. Forms MS2 and house cards were checked against each other 35 times and in 17 instances did not agree.

An attempt was made to verify the house visitors' report of slide collections from fever cases by inquiring of the individuals concerned as to whether or not the slide was taken and what had been the indications in taking the slide. Of the 16 people checked, 14 verified the house visitor's report. The two unverified cases were not available for interview, but the wife of one, and the mother of the other denied both the indications and the taking of a slide.

2. Bias in Slide Taking

In selected sectors the positive cases and a sample of the population from which ACD slides were taken were analyzed as to their age and sex distribution. These two distributions were examined and compared with each other and with the age-sex distribution derived from census figures to detect any bias in slide taking.

TABLE 8
AGE AND SEX DISTRIBUTION OF ACD SLIDES AND CASES, 1966

Zone; Sector			5: 5, 7, 8		3, 7 (Sumgmen)		5; 10		2; 13		1, 1 (L1)	
Age in Years	Sex	% Distribution Population of Thailand 1960 Census	% Slides	% Cases	% Slides	% Cases	% Slides	% Cases	% Slides	% Cases	% Slides	% Cases
<10	M	15.9	10	7	10	4	18	17	17	7	19	22
	F	15.5	9	7	9	2	16	13	15	5	11	14
10-39	M	25.3	30	55	35	68	26	38	23	64	34	44
	F	25.0	22	20	17	14	24	22	13	12	23	10
>40	M	9.0	15	11	16	10	8	6	17	8	7	7
	F	9.4	14	0	13	2.	8	4	15	4	6	3
All Ages	M	50.2	55	73	61	82	52	61	57	79	60	73
	F	49.9	45	27	39	18	48	39	43	21	40	27
Total numbers		26,257,916	1,936	44	2,795	875	1,821	618	1,362	236	176	145

Table 8 summarize this analysis. In every instance more slides were taken from males than females. Although the census figures in two sectors showed a slight preponderance of females, the imbalance in ACD slides is much greater. This bias is difficult to explain since one might suspect that the women who are at home might be more accessible to the house visitor than the men who are out in the fields. In some areas house visitors were encouraged to go to the fields, to contact the men there and perhaps the predominance of males represents success in these efforts.

In general, there were slightly fewer in the group under ten years of age and over forty in the ACD sample than was found in the census. However, in no area was the deviation extreme. Although not shown on Table 8, there was substantial under-representation in slide taking of the under 1 year age group.

3. Time Lags

The time interval between slide taking and administration of radical treatment is an important factor in reducing the gametocyte pool, both in areas of consolidation and in attack. Therefore, this interval was calculated for selected sectors and districts in all zones in Region 2.

The results of these calculations are shown in Table 9. Time lags ranged from treatment on the same day as the slide was taken to delays of upwards of 6 months. It will be noted that the shortest average time lag was 22 days, and the longest 51 days. Of the 8 sectors in consolidation for which a time lag was calculated, the average delay was 34 days between slide collection and radical treatment.

An attempt was made to break down the time lags and assess the contribution of each component but unfortunately the complete data were available for only a very few sectors. The results of these calculations are seen in Table 10.

The longest delay was generally in the time between the notification of the sector office of a positive slide and the administration of radical treatment. However, the time lag between slide taking and the availabibility of results in sector offices was generally substantial, and when information was available to break this down into components of time taken to reach the laboratory and time between receipt and diagnosis, a substantial delay in both factors was apparent.

A further attempt was made to see if delays were influenced by the rainy season or by the distance of the case from the sector office (Table 11).

When delays were looked at by month of slide collection, no pattern was seen suggesting a a strong climatic influence in time lag. When delays were arranged by distance of the case from the sector office, a consistent pattern was seen in one instance (Zone II, Li district) but not in the other two sectors (Table 12).

4. Epidemiologic Investigation, Radical Treatment and Case Follow-Up

Table 13 summarizes the information gathered in Region 2 as to rates of radical treatment of positive cases. The overall percentage of cases receiving radical treatment is 83%. However, of the 8 sectors in consolidation examined, 5 sectors showed treatment rates of 80% or lower.

The success of follow-up visits was evaluated by comparing the number of slides which were obtained with the number expected. Table 13 shows these results. The overall rate of success was 20%. The performance in the sectors in consolidation was, if anything, poorer than in other sectors.. Although much of the lack of success in obtaining follow-up slides can be attributed to visits which were unsuccessful in meeting the patients, there was a significant proportion of visits which were not even attempted.

Particularly distressing in consolidation areas was the lack of response to the information yielded by follow-up visits. There was no evidence of retreatment of cases which were positive on follow-up slides, or no evidence that any special effort was made to obtain further follow-up slides on patients that either remained or became positive. Although these practices may be of

TABLE 9
TIME LAGS FROM SLIDE COLLECTION TO RADICAL TREATMENT

	Average Number of Days from Slide Collection to Result Returned	Average Number of Days from Result Returned to Radical Treatment	Total
Zone 1			
Sector 6			41 (43)
Chiang Dao			
Sector 1			
Li District			26 (192)
Zone 2			
Sector 13			
Maetha & Kokha	18 (72)	17 (66)	35
Zone 3			
Sector 7			
Sungmen & Den Chai	6 (44)	45 (41)	51
Zone 4			
Sector 2*			
Bankdtum	13 (24)	26 (19)	39
Sector 3*			
Bangrakam	13 (24)	24 (20)	37
Phitsanulock*	9 (68)	20 (52)	29
Sector 4*			
Phromphiram	24 (12)	15 (10)	39
Sector 5*			
Kong Krailat	14 (10)	20 (9)	34
Sukothai	12 (43)	10 (35)	22
Sector 6	16 (27)	18 (24)	34
Sector 7*			
Sowankalo	17 (32)	9 (22)	26
Sesamlo	18 (15)	11 (15)	29
Zone 5			
Sector 6*			
Phothale	22 (134)	30 (105)	52
Sector 7*			
Taphanhin	15 (41)	26 (39)	41
Sector 9*			
Bangmunnak	13 (14)	22 (12)	35

Figures in parenthesis - number of cases reviewed

TABLE 10
TIME INTERVALS IN DAYS (AVERAGE)

	Between taking and receipt in laboratory	Between receipt and reading in laboratory	Between reading and start of medical treatment
Zone 2 Sector 13	9 (72)	9 (72)	17 (66)

Figures in parenthesis - number of cases reviewed

TABLE 11
TIME LAG BY MONTHS

		Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Total
Zone 5 Sector 6 Phothale	Slide taken to Results Received, days	13	25	15	5	10	14	0	18	13	12	-	-	22
	No. of Cases	56	2	21	5	1	6	0	1	18	24	-	-	134
	Result Investigated to Radical Treatment, days	26	61	38	22	59	26	0	14	27	37	-	-	30
	No. of Cases	47	1	20	5	1	5	0	1	11	14	-	-	105
	Total	39	86	53	27	69	40		32	40	49			52
Zone 4 Sector 3 Pitsanulok	Slide taken to Results Received, days	5	7	9	6	12	8	11	14	16	10	9	10	9
	No. of Cases	11	6	4	2	3	6	3	4	8	4	9	9	68
	Results Rec. to Radical Treatment, days	36	16	24	6	30	21	8	10	15	24	21	32	20
	No. of Cases	6	6	1	1	12	6	2	4	8	4	9	3	52

lesser consequence in attack areas, they greatly increase the hazard of reintroduction of transmission in areas in consolidation.

Epidemiologic investigation in consolidation areas is particularly important since rapid detection of the reintroduction of transmission and prompt application of control measures are the keystone to maintaining the progress gained by attack measures. To this end the investigating epidemiologist must gather information which will allow the geographic location of transmission to be identified. A mass blood survey of between 100 and 150 slides to detect the presence of malaria transmission is then required. On the basis of this information the decision of whether or not to apply focal spray measures is made.

TABLE 12
AVERAGE TIME LAG BETWEEN SLIDE COLLECTION AND RADICAL TREATMENT
BY APPROXIMATE DISTANCE OF CASES FROM THE SECTOR OFFICE

Zone	Sector	District	Distance from Sector Office in Km	Mode of Transportation	Average Time Lag	# of Cases
1	1	Li	0	Vehicle	19	51
			8	Vehicle & foot	24	42
			11	Vehicle & foot	24	17
			17	Vehicle & foot	26	29
			28	Vehicle & foot	36	12
			36	Vehicle	31	14
			37	Vehicle	28	19
			57	Vehicle & foot	48	8
1	6	Cheingdao	0		61	3
			4	Vehicle	41	3
			15	Vehicle	36	27
			17	Foot	30	1
			35	Foot	62	5
			70	Foot	31	4
2	13		"Near"		40	8
			"Far"		51	18

TABLE 13
PERCENT CASES GIVEN RADICAL TREATMENT AND PERCENT OF "FOLLOW-UP" SLIDES OBTAINED

Zone	Sector	District	No. Cases	# Radical Treatment	% Treated	# Follow-up Slides	# Expected Follow-up	% Follow-up Obtained
1	6	Chiengdao	46	43	93%	104	276	38%
2	1	Li	195	191	98%	154	888	17%
2	13	Maetha	74	66	89%	-	-	-
3	7	Sungmen	45	43	96%	-	-	-
4	3	Bangrakam*	24	20	83%	56	144	39%
4	3	Phitsanulock*	68	54	79%	128	348	37%
4	4	Pomprirum*	10	8	80%	-	-	-
4	5	Kong Krailat*	10	9	90%	10	60	17%
4	5	Sukothai*	43	35	81%	65	258	25%
4	6	Kirimat	27	24	89%	13	162	8%
4	7	Se Sam Ro*	15	11	73%	111	90	12%
4	7	Sowanralo	33	18	55%	-	-	-
4	2	Bangkratham*	24	15	62%	-	-	-
5	7	Taphanhin*	41	39	95%	-	-	-
5	6	Phothale*	145	110	76%	85	870	10%
5	8	Phichit	144	98	68%	-	-	-
Total			944	784	83	626	3096	20

* Area in consolidation

Table 14 summarizes the evaluators' appraisal of mass blood surveys done around positive cases in consolidation areas. The number of slides obtained in each instance falls considerably short of the goal of 100 to 150. There is no consistent correlation between the number of cases investigated and the number of slides obtained around each case suggesting that an undue load on case investigators is not primarily responsible for the low yield.

TABLE 14
SLIDES PER CASE INVESTIGATION AND SLIDE POSITIVITY RATE OF INVESTIGATION SLIDES IN CONSOLIDATION AREAS, 1966

Zone	Sector	District	No. of Cases Investigated	Slides Collected	Positive Slides	Slides Per Investigation	SPR from Investigation	SPR from ACD
4	3	Bangrakam	22	1042	1	47	0.1	0.7
	3	Phitsanulok	61	2522	1	41	0.04	0.18
	4	Prompiram	12	301	1	25	0.3	0.08
	5	Sukhothai	46	1085	5	24	0.5	0.37
	5	Kongkrailat	11	383	0	35	0	0.095
	7	Sesamrog	22	1335	3	61	0.2	0.167
	7	Swankalo	25	1572	0	63	0	0.024
5	5	Bangmunnak	240	1616	32	7	2.0	1.78
	6	Phothale	70	500	17	7	3.4	1.57
	8	Phichin	143	2057	7	14	0.34	0.97
	9	Samnang	30	636	9	21	1.4	0.53
		TOTALS	682	13,049	76	19	0.58	

Case classification as to the location of the transmission site in relation to the site where the case was detected is extremely important in assessing the amount of transmission taking place in a sector. Several of the areas now in consolidation in Region 2 have never been under attack. They were assumed to be non-malarious at the start of the program and only during the last 3 years placed under the scrutiny of consolidation phase surveillance. In these sectors the tendency is strong to classify a case on the basis that these sectors are non-malarious and therefore the case must be "imported". If there is absolutely no evidence of the infection having been acquired outside the sector, the cases may be classified as "indigenous" or "cryptic."

TABLE 15
FALCIPARIUM CASES CLASSIFIED AS NON INDIGENOUS IN WHICH PATIENT HAD BEEN AT HOME IN CONSOLIDATION AREA FOR 6 WEEKS OR MORE PRIOR TO ONSET OF FEVER

Zone	Sector	District	Total Cases Successfully Investigated	Last Time Out of District Prior to Onset of Fever				
				6 Weeks	3 Months	6 Months	1 Year	Never
4	3	Muang	54	1	7	1	7	-
	3	Bangham	15	1	-	-	-	2
	5	Muang	35	-	-	-	2	1
	7	Sawankhalok	18	1	2	-	-	-
5	8	Phichit	109	1	4	4	5	1
	9	Samngam	27	6	6	1	1	-
Total				10	19	6	15	3

Table 15 summarizes a review of case classification in selected sectors in the consolidation phase. Since the time interval between infection and symptoms in P. vivax may be extremely variable, only falciparum cases were examined.

It is true that the usual short incubation period may be prolonged in falciparum malaria. However, the occurrence of falciparum cases in which the last known exposure outside the sector in consolidation was from three months to over a year prior to the onset of symptoms should raise the suspicion of indigenous transmission.

Investigations of indigenous cases in consolidation areas were infrequent and usually occurred several months after transmission took place. This time lag often means the investigation takes place in the dry season while the transmission takes place in the wet. One case in point was that of a four year old boy who developed malaria but who had never been out of the village of his

birth. The investigation team which looked at the local situation during the dry season several months later were unable to find any vector mosquitoes and accordingly concluded that the case could not be indigenous. However, entomologic data from a near-by sector showed a similar absence of vectors at that time of the year but also showed that vectors were present in the wet season, the probable season of transmission. Accordingly, if the time lag between onset of of symptoms and the arrival of an investigation team cannot be decreased, changes in environment that have occurred during this period should be taken into account in making the epidemiologic evaluation.

E. LABORATORY SERVICES

In evaluating the diagnostic facilities, the condition of the laboratory, the work output, the accuracy of diagnosis, and the quality of slide-making and staining were reviewed.

In general, laboratory conditions were good. Working conditions ranged from adequate to good in regard to lighting, ventilation and space. Supplies were in general adequate. However, in the Zone II laboratory, gasoline was being substituted for xylene as a slide-cleaning solution. This serious safety hazard was reportedly present for a month prior to the survey visit and was occasioned by an inadequate flow of supplies.

The general condition of microscopes was good although many were in need of minor repairs. No tools or lubricating oil were present for minor servicing, as it is apparently the policy that all repairs are done at the National Headquarters. Because of the time required for this procedure it seems that the general practice is to postpone repairs until the microscope is unusable.

Table 16 shows the efficiency of the zone laboratories as measured by the number of slides read per microscopist working day, averaged over a month.

The overall average for the five laboratories for the year 1966 is 63 slides per day. In many laboratories there is considerable variation from month to month ranging from the 40's to the 70's. It was felt by the laboratory personnel that training of new microscopists may have resulted in variation in output.

TABLE 16
SLIDES EXAMINED PER MAN DAY BY MONTH AND ZONE - Region II, 1966

Zone	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.
Zone I												
No. of Slides	10,386	8,723	9,720	5,969	4,914	10,944	9,520	18,425	21,869	19,759	25,180	28,820
Slides/Man Day	68	70	71	50	49	47	56	68	71	71	70	72
Zone II												
No. of Slides	11,475	12,231	12,011	10,177	10,633	9,214	10,220	16,804	18,990	16,485	16,145	16,334
Slides/Man Day	61	57	63	74	71	65	60	60	66	65	66	66
Zone III												
No. of Slides	9,005	9,375	10,083	6,564	6,701	7,822	9,007	10,761	9,625	-	9,995	14,667
Slides/Man Day	49	63	62	45	51	48	58	59	52	-	67	68
Zone IV												
No of Slides	-	8,114	11,120	9,068	9,909	8,395	10,269	13,498	14,061	13,496	14,100	15,283
Slides/Man Day	-	58	72	68	73	69	62	69	66	69	-	78
Zone V												
No. of Slides	10,274	6,662	7,816	4,194	6,643	7,437	6,941	10,658	9,725	16,879	16,895	-
Slides/Man Day	65	60	64	48	64	68	57	58	54	66	65	-

Table 17 shows the results of checking a sample of negative slides by the regional and national laboratories. It will be seen that there is a fairly close agreement between the figures observed by the national laboratory and those observed by the regional laboratory. Zone 1 laboratory was the most accurate, with Zone 2 laboratory a close second. It will be noted

that the accuracy of the Chief Microscopist roughly parallels that of the laboratory as a whole. Since the Chief Microscopist trains new personnel and arbitrates on difficult slides, this parallel is not unexpected. It is unfortunate that the laboratory which has the poorest record for accuracy, Zone 5 laboratory, covers areas in consolidation.

TABLE 17
PERCENTAGE OF MISSED POSITIVES BY ZONE AS DETERMINED
BY NATIONAL AND REGIONAL LABORATORIES
REGION 2, 1965 AND 1966

Zones	1965		1966	
	Regional Lab	National Lab	Regional Lab	National Lab
*1	0.28	0.33	0.13	0.16
2	0.17	0.29	0.48	0.37
3	0.60	0.77	0.88	1.01
*4	0.40	0.49	0.34	0.32
5	0.84	1.15	1.62	1.28
Total	0.46	0.61	0.69	0.63
Lab Chiefs				
1	0.01		0.14	
2	0.00		0.00	
3	0.82		1.55	
4	0.84		0.80	
5	1.15		0.60	
Regional Lab		0.40		0.21

* Contains sectors in consolidation.

TABLE 18
DEFECTS IN SLIDE PREPARATION AND STAINING OF THICK SMEARS

Zone	Sample Examined	Poorly Dehemoglobinized	Debris	Too Thin	Poor Stain	Flaking or Insect Damage
1	20	3	3	2	-	-
2	20	3	1	-	3	-
3	20	6	2	2	3	2
4	20	7	1	2	1	-
5	20	2	2	1	2	1
Total	100	21	9	7	9	3

The results of evaluation of slide preparation and slide staining are shown in Table 18. A slide was considered unsatisfactory if one or more of the factors evaluated was so deficient as to make it impossible to exclude the presence of parasites in the slide. Since the evaluation of slides was done by different members of the team in different regions, they are not strictly comparable. In addition, constant work with less than perfect slide-making and staining may enable a microscopist to read slides an outside evaluator feels are impossible to read.

In spite of these qualifications, however, poor quality slide-making and staining seriously compromises the efforts of the surveillance network to provide the meticulous cover essential

to a successful consolidation phase. Of particular importance, therefore, is the finding that two of the three zones containing areas in consolidation (Zones 1, 4, and 5) have an unsatisfactory slide preparation rate which is higher than the average for the Region. It was also noted that Form L5c on which unsatisfactory slide preparation is to be reported were not being used.

F. SUPERVISION

Data surveyed indicate that there was a correlation between good performance by the house visitor and frequent supervision. The quality of supervision was much more difficult to assess. On a few occasions it was possible to visit a house visitor on the same day that he was being visited by a squad chief. It was apparent that the comments and suggestions made in the house visitor's book were frequently general and that specific, important deficiencies were not dealt with. In certain zones in Region 2 a form which required the squad chief to make objective appraisals of several specific points of evaluation of the house visitor was in trial use. Number values for each specific point assessed were then totaled and rated against a scale of 100. This form of rating the work of house visitors seemed to be working well and appears to offer a partial remedy for the reluctance on the part of squad chiefs to declare that a house visitor's performance was "bad."

The concept of a chain of responsibility from a supervisor to the next senior in line for the work performance of a group of employees was poorly developed. Although representatives from region, zone, and sector alike frequently supervise the house visitor, it is rare that the system of supervision, which allowed suboptimal performance to flourish, was examined and corrected. Supervision of squad chiefs by sector chiefs, sector chiefs by zone chiefs, and zone chiefs by regional officers was infrequent and informal.

G. SPECIAL EPIDEMIOLOGIC OBSERVATIONS

In the course of examining the age and sex distribution of positive cases and of contributors of ACD slides, it became apparent that in some areas sampled there was a preponderance of malaria infections in males in the 10 to 39 year old age group. Specifically in Sungmen, Sector 7, Zone 3, 68% of the cases occurred in this group, against an expected rate of 35%; in Maetha, Sector 13, Zone 2, 64% of the cases were in men of ages 10 to 39 compared to an expected rate of 23%; in Sectors 7 and 8, Zone 5, 55% of cases occurred in this group against an expected rate of 30% (see Table 8 from Section D-2). This is a marked deviation from the distribution of cases expected and observed when the vector is a nocturnal, indoor biter. The high incidence in young active males suggests a vector that bites away from the house. It either bites during the day, or, if a night biter, its habitat is such that men are predominantly at risk.

The information known about the breeding sites and habits of A. balabacensis in Thailand suggests that it may contribute to this selective distribution of malaria. The custom of males going unaccompanied to distant fields or to the forest provides the opportunity for selective exposure to this vector.

With these possibilities in mind, zone chiefs were questioned as to their knowledge of specific seasonal or occupational migrations. The chief of Zone 3 described seasonal and occupational migration patterns which he felt influenced the occurrence and distribution of malaria in his zone. The rice-growing season extends from July to December and January. After the harvest in January many of the men leave the village looking for work. They may go to the forests for logging or growing other crops in clearings, or to fields at the bases of hills where vegetable crops are grown. They return in April for the New Year holidays. Some remain but some leave the village again to return to the occupation of the immediately preceding months. All return in July for planting the new rice crop.

During the rice-growing season, there are migrations of a different nature involving both sexes. Often rice fields are a journey of a day or more from the village homes and during the rice-growing season one or more members of the family will be away from home tending the crop, living in a temporary hut or shelter in the fields. They will return in a week or two and other

family members will leave to tend the crops. Thus, the family maintains and occupies two residences during the rice-growing season, its permanent house in the village and a crop hut in the rice fields.

The return home of the men in April and again in July was said to result in an increase in malaria in the villages at those times. To test this hypothesis a sector in which these migrations were most frequent was picked by the zone chief and the age and sex distribution of positive cases and ACD slide donors were examined by month. Table 19 shows the results of this examination.

TABLE 19
POSITIVE CASES AND A SAMPLE OF ACD SLIDES BY AGE, SEX, AND MONTH OF COLLECTION

CASES

Age Group		J	F	M	A	M	J	J	A	S	O	N	D	Total
-10	Male	0.5	0.5	-	0.2	0.8	-	0.1	0.6	0.8	0.2	0.2	0.2	4.1
	Female	0.5	0.1	0.2	0.1	0.3	-	0.2	-	0.1	-	0.9	-	2.5
10-39	Male	6.7	10.2	13.9	5.1	2.9	2.3	5.1	4.0	3.3	4.0	5.8	4.6	68.0
	Female	1.8	1.2	0.9	0.3	0.2	0.3	1.5	2.2	0.7	0.7	2.9	0.8	13.6
+40	Male	0.7	1.8	1.6	0.1	0.1	0.1	1.0	1.0	1.0	0.2	1.5	0.6	9.8
	Female	0.1	0.3	0.1	-	-	0.3	0.1	0.6	-	-	0.2	0.1	1.9
Total														
	Male	7.9	12.5	15.5	5.5	3.8	2.4	6.3	4.5	5.1	4.5	7.5	5.4	81.9
	Female	2.4	1.7	1.2	0.5	0.6	0.7	1.8	2.7	0.8	0.7	4.0	0.9	18.1

Total Number of Positive Cases - 875

ACD SLIDES

Age Group		J	F	M	A	M	J	J	A	S	O	N	D	Total
-10	Male	0.6	0.9	0.4	0.5	0.9	0.9	0.9	0.4	0.8	1.6	0.8	1.5	10.2
	Female	0.4	0.4	0.4	0.6	0.5	0.5	1.4	0.4	0.7	1.2	0.8	1.6	8.9
10-39	Male	3.1	2.4	3.1	3.2	2.9	2.6	2.4	2.1	3.3	4.5	2.8	2.8	35.2
	Female	0.6	1.2	1.0	1.4	1.5	1.2	1.0	1.1	1.1	2.6	1.5	2.5	16.7
+40	Male	0.9	1.3	1.6	1.3	0.9	1.5	0.8	1.4	1.1	1.9	1.3	2.0	15.8
	Female	0.8	1.3	0.8	0.8	1.0	1.0	0.8	1.6	1.0	1.5	0.9	1.7	13.2
Total														
	Male	4.7	4.5	5.2	5.0	4.7	4.9	4.0	3.9	5.1	8.1	4.9	6.3	61.2
	Female	1.8	2.8	2.2	2.8	3.0	2.7	3.2	3.1	2.9	5.3	3.2	5.8	38.8

Total Sample of ACD Slides - 2795

One notes that the predominance of male cases is greatest in February, March and April. If this is indeed the period during which most of the men are away from the village, it is unlikely

that they are contributing to this increase, unless they return home frequently as they become ill. The case rates among men in July and August are not unusually high, however, sugesting that a return of men to the village at this time is not making a large contribution to malaria incidence.

In attempt to quantitate the amount of migration, the number of slides collected specifically because an individual slept away in the preceding month was compared with the total number of slides taken. Table 20 summarizes this information for Songmen. There is no clear cut pattern here, and no correlation was found between the percent of those sleeping away and either the number of male cases or the ratio of male to female cases. It is quite possible, however, that these figures do not reflect the true incidence of migration since the issue of having slept away from home in the preceding month is frequently overlooked by the house visitor.

TABLE 20
PERCENTAGE OF PERSONS SLEEPING AWAY FROM HOME BY MONTH
SUNGMEN DISTRICT, ZONE III, 1966

Month	No. of Slides	No. Slept Away	% Slept Away
January	1059	187	18
February	1403	287	20
March	1451	331	23
April	486	95	20
May	442	56	13
June	929	181	19
July	1300	180	14
August	1966	177	9
September	450	32	7
October	841	173	21
November	1336	280	21
December	2169	253	12

While this examination of the data at hand mainly indicates trends and poses questions, it does point out areas for further study and quantitates the degree to which the male risk of malaria is increased over that of the female. Some answers may be obtained by studying the vectors in these areas, and by trying to determine where and when the male population is at greatest risk. It is quite probable that this type of examination will suggest supplemental measures of attack which, because they are fitted to the epidemiologic facts of the specific area, could produce greater return for effort than the mass application of the few known supplemental eradication techniques.

REGION 3 SURVEY

INTRODUCTION

The following report is based on data collected and personal observations made during a field trip to Region 3 from March 10, 1966 to March 25, 1966.

While general data were collected at Region 3 Headquarters, sectors in Zone 1, 2, 4 and 6 were selected for closer study. From each of the sector maps one canton was then chosen and from the canton maps 2 villages were randomly taken as targets for a house to house survey.

In all, 8 villages, 4 sector headquarters, 4 zone headquarters and the Regional Office were visited. Map No. 1 outlines the zones and sectors which were visited.

Region 3 covers the northern half of northeast Thailand. The boundry to the north and east is the Mekong River which separates Thailand and Laos. To the west there is a common border with Region 2 while to the south a small area abuts on Cambodia. The essential geographic feature is the central rice-growing plain, largely encircled by hills which cut it off from cooling southeastern winds.

The estimated population of the Region in 1966 was 6,717,252, the majority of which is rural dwelling and mainly located in the central rice-growing area. The village communities all live in typical Thai houses raised on stilts and there are many new homes either recently finished or being built. Numerous field shelters and huts are scattered thoughout the area.

A. CURRENT STATUS OF MALARIA ERADICATION

Since 1964 the whole of Region 3 has been in the attack phase with at least one cycle of house spraying annually. In 1963 ACD was introduced in Zones 1, 4 and 6. Since then, ACD surveillance has been extended to cover a population of 4,337,223. Map No. 2 shows the activities of the NMEP in the Region during 1966.

Table 1 represents the results of Active Case Detection by Province for Region 3 from 1963 to 1966.

TABLE I
ACTIVE CASE DETECTION - REGION 3
1963 - 1966

	1963		1964		1965		1966	
Province	ABER	API	ABER	API	ABER	API	ABER	API
Khonkaen	12.3	1.4	13.1	1.7	13.2	1.2	12.7	0.9
Udornthani		ACD begun in 1965			12.7	1.8	1.21	0.6
Nonghai		ACD begun in 1965			24.0	27.0	12.4	8.9
Sakolnakorn		ACD begun in 1965			18.3	5.8	14.5	3.1
Mahasarakam	9.7	2.2	14.5	2.0	12.9	1.4	11.7	0.8
Kalasin	8.6	2.1	10.5	1.7	10.2	1.5	13.6	1.9
Ubolrachatani	8.7	4.3	9.5	5.2	11.3	3.1	11.7	0.6
Roi-Et	9.8	6.6	11.7	6.6	9.2	6.8	14.2	2.1
Totals	10.5	3.3	12.5	3.3	11.7	3.4	12.7	1.8
Population under ACD	2,349,018		2,429,870		3,577,093		4,337,223	

The API remained stable from 1963 through 1965, but a pronounced drop was observed in 1966. Out of 49 districts having comparable data, 42 showed decreases in API and SPR (Table 1, appendix) between 1965 and 1966. Thus the overall trend has been downward.

The apparent stability in API in 1964 and 1965 may reflect better case finding because of an increase in ACD surveillance.

Of the seven districts showing an increase in API, four were located in the province of Mahasarakam. Movements of population are cited as the principal reason for this increase.

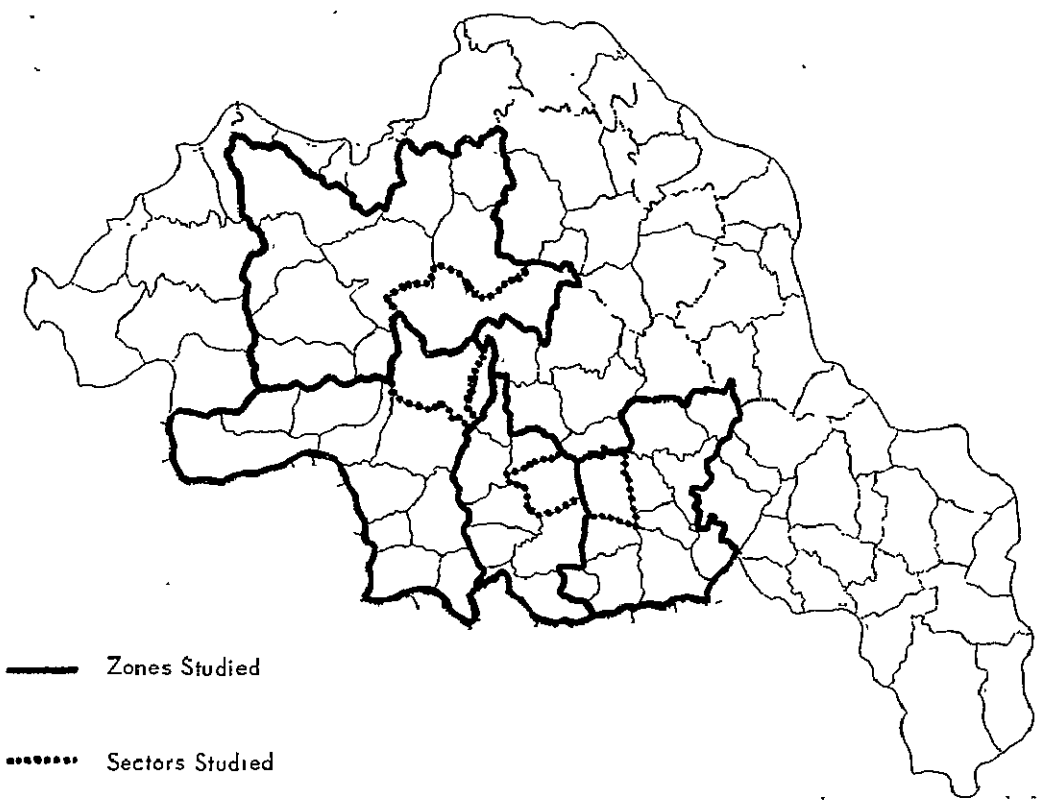
In two provinces (Loey and Nakornphanom) ACD has not yet been undertaken and surveillance has been by malariometric survey. Spray activities have been carried out since 1964 and Table 2 presents the malariometric survey data from these areas.

TABLE 2
RESULTS OF MALARIOMETRIC SURVEYS
LOEY & NAKORNPHANOM, 1963-1966

	1963		1964		1965		1966	
Province	No. of Slides	Percentage Positive	No. of Slides	Percentage Positive	No. of Slides	Percentage Positive	No. of Slides	Percentage Positive
Loey	6,131	6.14	11,347	2.27	9,553	1.25	12,089	1.52
Nakorn-phanom	11,098	1.75	18,583	2.38	13,790	.51	19,534	.45

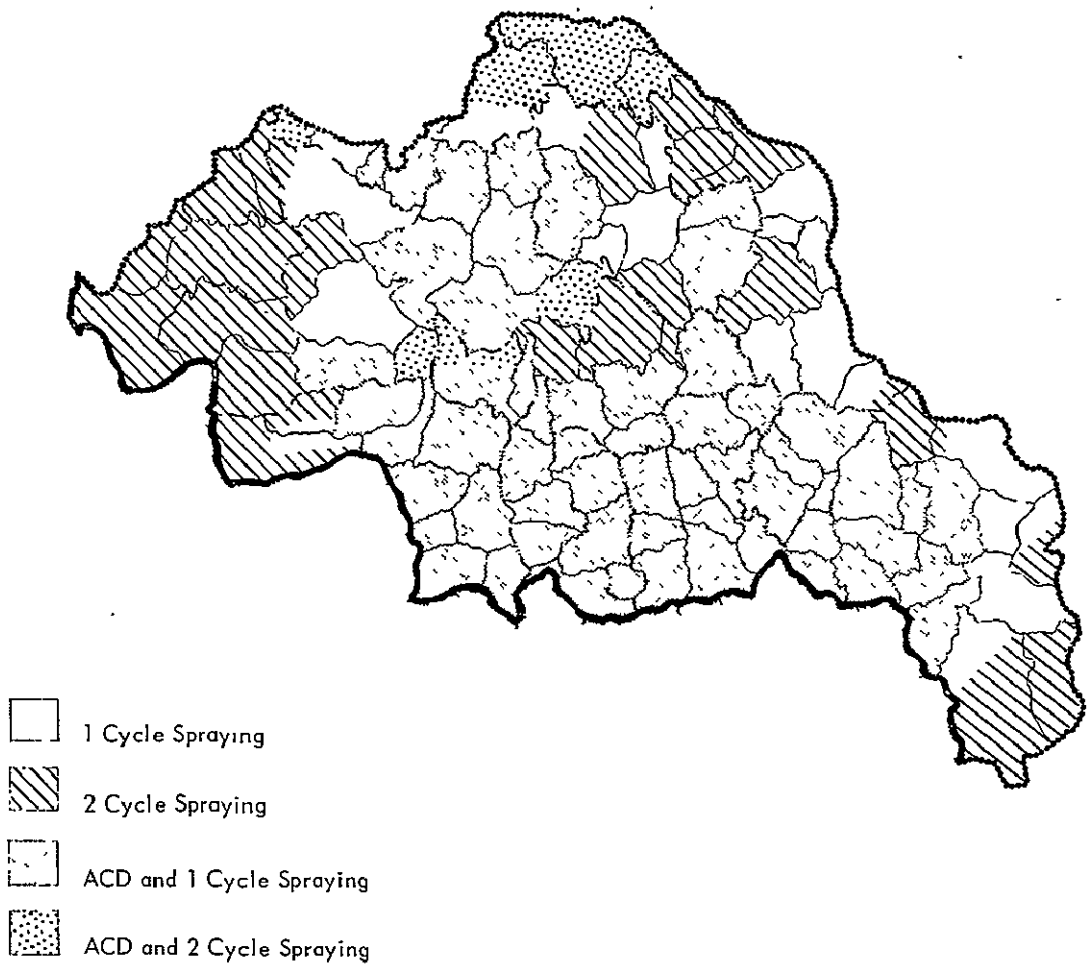
MAP NO. 1

REGION 3 KHONKAEN
ITINERARY



MAP NO. 2

REGION 3 KHONKAEN
NMEP ACTIVITIES 1966

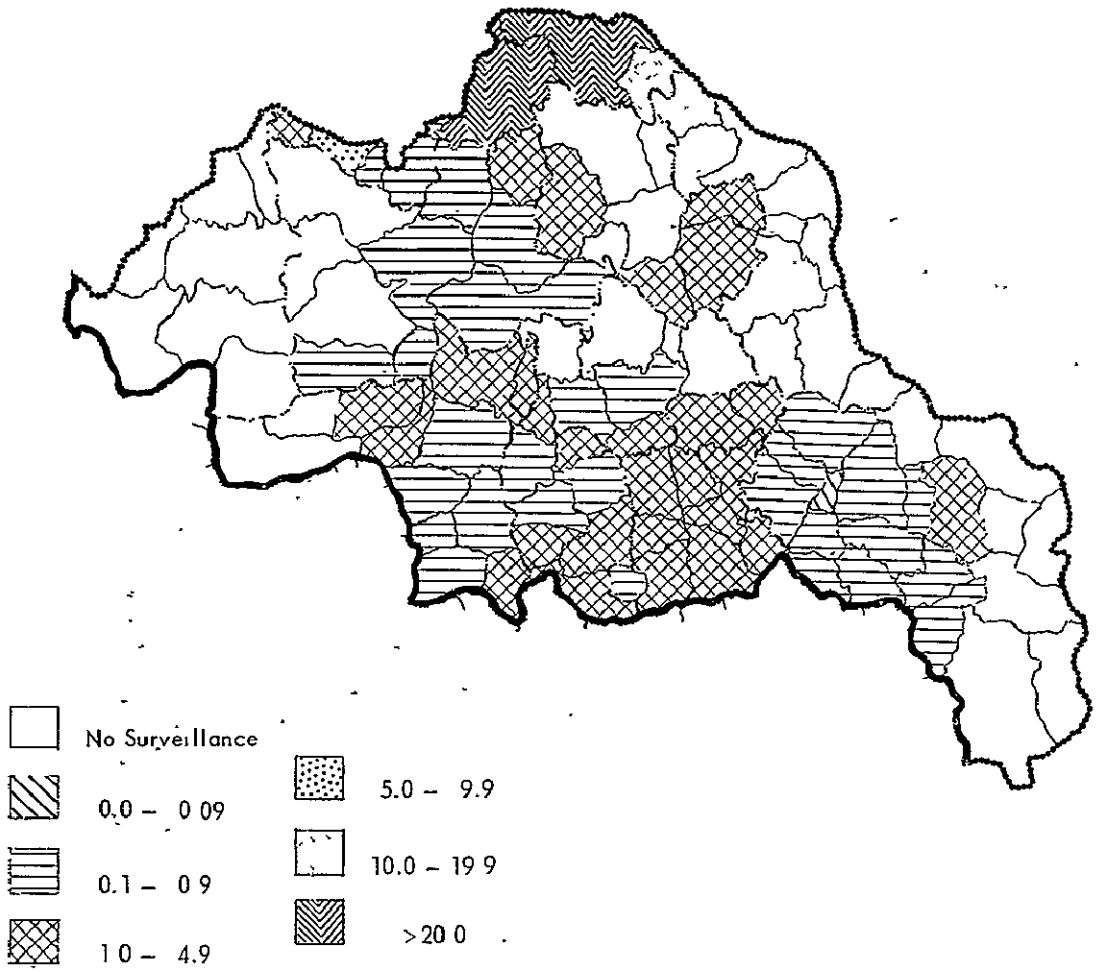


Although there has been a substantial decrease in malaria incidence since the end of 1964, there was little real decrease between 1965 and 1966. However, it is too early to draw conclusions and more data will be required before a definite trend is visualized.

Map No. 3 shows the current API's for districts under ACD. The highest API's were recorded in Nongkai Province which borders on Laos. There has been no organized anti-malaria program in Laos since 1960 and the high API in Nongkai is thought to reflect the migration patterns across the Mekong River.

MAP NO. 3

REGION 3 KHONKAEN
API 1966



B. SPRAYING OPERATIONS

1. General

A summary of the attack measures in Region 3 since 1964 is presented in Table 3. The DDT coverage has increased as shown by the number of villages sprayed each year. In 1964, 6,877 villages were sprayed compared to 9,970 in 1966. The general trend of using more DDT is shown by the increase from 116.3 to 128.7 of gm of 75% DDT per capita. Table 4 shows the distribution of increases in grams per capita. The increases were most pronounced in areas with ACD surveillance, and in provinces of Loey and Sakolnakorn, where no ACD surveillance was done, the lowest percent increase in per capita consumption of DDT was recorded. The inference is that where ACD surveillance was functioning more DDT was being used.

TABLE 3
SUMMARY OF ATTACK MEASURES (FIRST SPRAY CYCLE)
REGION 3, 1964-1966

	1964	1965	1966
Villages	6877	8732	9970
House			
Sprayed* Tot/Inc	712,199	957,037/19,287	1,028,512/20,255
Missed** Lock/Ref	10,365	11,437/12,686	10,656/26,463
% Miss	1.4	2.5	3.6
No. occupants			
Sprayed	4,203,632	5,537,194	5,691,475
Per house	5.9	5.7	5.5
No. Sq. M.			
Sprayed	169,282,305	222,182,682	259,986,326
Per house	237.6	232.1	252.7
Per capita	40.2	40.1	45.6
No. (Kg.) 75% DDT			
Used (Kg)	488,949.5	673,293.0	732,611.5
Per house (gm)	686.5	703.5	712.3
Per capita (gm)	116.3	121.5	128.7
Dosage gm/sqm	2.10	2.25	2.10
No. sprayman days	72,665	101,625	112,129
No. house/spm/day	9.8	9.4	9.1
Sqm sprayed/spm/day	2329.6	2185.7	2318.6

*Tot/Inc = Total Sprayed Houses/Incompletely Sprayed Houses.
**Lock/Ref = Locked Houses/Refusals.

2. Field Survey of Spraying Operations

A total of 238 houses in 8 villages were evaluated for spray coverage. The villages were all randomly selected. The houses were rated as completely sprayed, incompletely sprayed, or missed. Complete coverage was judged by residual DDT in all parts of the house as well as under the eaves. The results of the survey are shown in Table 5.

All of the villages surveyed were small except Khao Suan Kwang. Here, urban resistance to spraying was very pronounced and only 10% of the houses visited could be classified as having been completely sprayed; at most homes only outside spraying was allowed by the house owner.

The quality of rural spraying on the other hand was truly impressive. The coverage in general was excellent even in areas where access was difficult.

Some villagers complained that DDT application aggravated the bedbug problem. Walls in some homes had been washed free of DDT.

TABLE 4
*DISTRICTS SHOWING INCREASE IN DDT/CAPITA 1965-1966

Province	No. of Districts	No. Districts Showing Increase DDT/Capita 1965-1966	Percent Showing Increase
Khonkaen	10	7	70.0
Loey	6	2	33.0
Udornthani	8	8	100.0
Nongkhai	6	2	33.0
Sakolnakorn	8	1	12.0
Nakornphanom	9	5	55.0
Mahasarakham	8	6	75.0
Kalasin	7	5	71.0
Ubolrajthani	19	11	58.0
Roi Et	10	8	80.0

*Only districts with comparable data were included.

TABLE 5
ASSESSMENT OF SPRAY COVERAGE IN 8 RANDOMLY SELECTED VILLAGES

Zone	Canton	Village	No. of Houses Seen	Missed #	Missed %	Sprayed #	Sprayed %	Quality of Spray: Complete # Houses	Complete %	Incomplete # Houses	Incomplete %
2	Siaw	Kraeung	28	0	0	28	100	25	89.3	3	10.7
		Kudyang	30	0	0	30	100	23	76.7	7	23.3
1	Khao Suan Kwang	Khao Suan Kwang	29	4	13.8	25	86.2	3	12.0	22	88.0
		Koakswang	30	2	6.7	28	93.3	23	82.1	5	17.9
6	Suanjik	Soakchak	31	2	6.5	29	93.5	27	93.1	2	6.9
		Nonghi	30	0	0	30	100	25	83.3	5	16.7
4	Tatoom	Coaklaam	30	1	3.3	29	96.7	23	79.3	6	20.7
		Tangaam	30	0	0	30	100	23	76.7	7	23.3
		Totals	238	9	3.8	229	96.2	172	75.1	57	24.9

C. RELIABILITY OF COMMUNICATION OF DATA AND DATA PRESENTATION

1. Data Communication

ACD visits as recorded on MS3 forms were checked at sector, zone, and region offices in order to determine the reliability of transmission of data. (Table 6)
Transmission of data was uniformly accurate from the zone to the region. However, the accuracy of the sector records varied considerably from sector to sector.

2. Data Presentation

a. Sector Offices

At one sector office the sector chief had a sound knowledge of malaria trends in his area. Unfortunately, this was not the case at the three other offices visited, where trends were poorly understood or not known.

The forms, MS2 and MS3, could not be found in two of the four sector offices. In one sector office, the MS3 forms for 1966 had been discarded. Maps and graphs at sector offices were usually plentiful but it was difficult for the team to evaluate the usefulness of the pictorial data displayed.

b. Zone Offices

Here again, a great range in the quality of zone chiefs was apparent. ABERs and APIs were not being calculated in any of the zone offices and the quality of records was also variable. Not one of the zone offices had a complete set of MS2 forms for a sector previously selected for investigation. In two of the four zones records for one month were missing; in one, zone records for three months were absent and, in another records for seven months were not available. MS8 forms were universally well kept at both sector and zone offices.

TABLE 6
COMPARABILITY OF DATA*

Levels Compared From	To	No. Figures Examined	No. of Discrepancies	Percent Discrepancies
Sector 8	Zone 1	120	28	23.3
Sector 4	Zone 6	120	0	0.0
Sector 6	Zone 4	120	2	1.7
Total		360	30	8.3
Zone 1	Region 3	60	0	0
Zone 6	Region 3	60	0	0
Zone 4	Region 2	60	0	0
Zone 2	Region 3	60	0	0
Total		240	0	0

*NOTE: Sector 2 transmission of MS3 data could not be checked since the MS3 forms were not available at the sector office.

D. SURVEILLANCE NETWORK

1. Visitors Activities

Daily blood smear collections by village were reconstructed for 14 house visitors from MSIA forms and maps at the sector offices. Since there was a general reorganization of house visitor itineraries in May, 1966, only the past 6 months were selected for study. Since this period of July to December encompassed a large part of the rainy season, it was felt that no great bias was being introduced.

Table 7 summarizes the results of the analysis of 14 house visitor itineraries. For each itinerary the number of days was calculated on which ACD slides were collected during 5 out of the 6 months. This was then expressed as a proportion of the total days in the itinerary. In addition, for each of the 14 itineraries the number of monthly cycles for which ACD slides were collected during at least three-quarters of the itinerary was determined. This number was expressed as a percentage of the six visiting cycles analyzed during 1966.

Overall, the daily slide collection was excellent in each of the house visitor itineraries studied.

The slides collected for the entire sector over six months were then added in order to calculate a "sector fever rate". The number of smears per hundred in each village was then compared to the overall rate. The great majority of villages had fever rates in the same range as the "sector fever rate".

In summary, the ACD slide collection in each of the four sectors studied showed excellent distribution both temporally and geographically.

TABLE 7
DAILY ANALYSIS HOUSE VISITOR SLIDE COLLECTION - JULY.-DEC., 1966

Zone	Sector	House Visitor	No. Days in Itinerary	No. Days ACD Slides 5 mos.	% Days ACD Slides 5 mos.	% house visitor cycles where ACD slides collected 3/4 days of itinerary
1	8	Yoan	24	22	91.7	100
		Cometon	24	24	100	100
2	3	Sakorn	23	20	87.0	83.3
		Nikon	23	21	91.3	100
		Sumrit	23	23	100	100
4	6	Piboon	25	21	84.0	100
		Kriangsak	25	25	100	100
		Montri	25	25	100	100
		Tawiap	25	24	96.0	100
		Sa-ngiam	25	25	100	100
		Prawit	25	22	88.0	100
6	4	Tongkon	25	24	96.0	100
		Tawat	25	25	100	100
		Prasert	25	25	100	100

In order to determine the quality of the house visitor's work, a total of 8 villages were randomly selected for a house to house survey. Two villages in each sector were visited. Each village was part of a house visitor itinerary which had been evaluated. About 30 houses in each village were visited. The following items were checked at each house:

a. presence of a malaria card
b. appropriate house visitor signature during preceding two months
c. location of house on itinerary map
d. spray coverage (see previous section)

The following questions were then asked of the head of the household:

a. do you know what malaria is?
b. do you know the house visitor?
c. were there any current fevers in the house?

All answers were tabulated on a yes-no form.

The results of this survey are in Table 8. An overall house sample of 17% was obtained and ranged from 1% to 68%. Two-thirds of the houses seen were on the HV map but this varied from sector to sector. In Zone 1, Sector 8, villages were seen where only 20% and 48% of the houses were appropriately positioned; in Zone 6, Sector 4, the map accuracy was 97% and 87%.

A malaria card was present in 92% of all houses. Those with missing cards were usually new houses built within the previous 4 months, or those where the card had been lost. However,

only 71.8% of homes had been signed by the house visitor since January, 1967; there was again great variation from village to village.

Interestingly, this absence of house visitor signature was not reflected in the forms filled out by the house visitor (MS1a). In three cantons house visitor summaries (MS1a) were checked with data collected on the house to house survey (Table 9).

TABLE 8
RESULTS OF HOUSE TO HOUSE SURVEY IN 8 RANDOMLY SELECTED VILLAGES

Zone-Sector	Z1-S8				Z2-S3				Z4-S6				Z6-S4					
Canton	Khao Suang Kwang				Siaw				Tatoom				Suanjik				Total	
Village	Koakswang		Khao suan-kwang		Kraeung		Kudyang		Coaklaam		Tangaam		Soakchuak		Nonghi			
Houses	292		536		135		134		44		63		74		67		1345	
Population	1455		2951		791		1120		298		372		483		459		7929	
Number of Houses Seen On Survey (Sample)	30		29		28		30		30		30		31		30		238	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
1. Houses on Itinerary Map	6	20	14	48	20	71	16	53	25	83	24	80	30	97	26	87	161	68
2. Houses with Malaria Card	21	70	26	90	26	93	26	87	30	100	20	100	30	97	30	100	219	92
3. Houses with Signed Card (within past two months)	15	50	26	90	17	61	14	47	26	87	20	100	16	52	27	90	171	72
4. Houses where one or more persons "knew" about malaria	28	93	26	90	22	79	23	77	29	97	29	97	40	97	28	93	215	90
5. Houses where one or more persons knew the house visitors	26	87	27	93	25	89	21	70	28	93	29	97	22	71	30	100	208	87
6. Houses with Fever	3	10	0	0	4	14	5	17	2	7	1	3	0	0	0	0	15	6

TABLE 9
FIELD VERIFICATION OF MS1A DATA

				MSIA DATA HOUSES			HOUSE SURVEY DATA HOUSES			
Zone	Canton	Village	Month	Target	Visited	Percent	Visited	Signed Card	Percent	Discrepancy in Percentages
1	Khaosuankwang	Koakswang	Jan.	292	292	100	30	15	50	50
	Khaosuankwang	Koakswang	Feb.	292	292	100	30	15	50	50
	Khaosuankwang	Khaoswankwang	Jan.	536	534	99.6	29	26	89.7	10
	Khaosuankwang	Khaoswankwang	Feb.	540	522	96.7	29	26	89.7	7
	Tatoom	Tangaam	Jan	63	63	100	30	30	100	0
	Tatoom	Tangaam	Feb.	63	61	96.8	30	30	100	3
	Tatoom	Coaklaam	Jan	44	44	100	30	23	76.7	23
	Tatoom	Coaklaam	Feb.	44	44	100	30	20	66.7	33
6	Suanjik	Soakchuak	Jan.	74	76	103	31	13	41.9	61
	Suanjik	Soakchuak	Feb.	74	74	100	31	12	38.7	61
	Suanjik	Nonghi	Jan.	67	67	100	30	25	83.3	17
	Suanjik	Nonghi	Feb.	67	67	100	30	23	76 7	23
	Total	January		1076	1076	100	180	136	75.6	24
		February		1080	1060	98 1	180	126	70 0	28

Discrepancies ranged from 61% to 0%, while an overall discrepancy of 24% in January and 28% in February was noted. In only one village was the degree of coverage similar to that reported by the house visitor. In all other villages this was not the case. Rather, the general trend was to grossly overreport the number of houses visited.

Most villagers stated that the house visitor did indeed go from house to house but in a few instances it was said that he simply "walked past the house" or "only signed the card".

Thus, the apparent excellent coverage by analysis of the MS1A forms was in large part negated by the results of the field survey.

2. Time Intervals

Time lags in surveillance procedures at the sector offices were evaluated along two parameters. Using the MS8 data in each sector office, the following were tabulated: (a) the time interval between slide taking and the positive result being forwarded to the sector chief and (b) the number of days between slide taking and the institution of radical treatment. All positive ACD sector cases were analyzed; the results are tabulated in four day intervals in Table 10.

TABLE 10
TIME INTERVAL DATA - FROM POSITIVE ACD SLIDES, 1966 - 5 SECTORS

		CUMULATIVE PERCENT Days from slide collection to forwarding of result to sector chief Days							CUMULATIVE PERCENT Days from slide collection to institution of radical treatment Days						
Zone	Sector	Total Cases	1-4	5-8	9-12	13-16	17-20	>20	Total Cases	1-4	5-8	9-12	13-16	17-20	>20
1	8	137	9	49	79	95	97	100	111	1	5	16	45	61	100
1	10	83	28	59	86	95	98	100	78	3	27	56	73	86	100
2	8	111	13	17	23	44	59	100	82	2	6	6	7	9	*97
4	6	47	34	74	94	98	100	-	41	10	29	37	63	66	100
6	4	92	41	83	93	96	98	100	86	10	43	73	93	97	100

*3% of cases contacted were not given radical treatment.

Two representative curves are presented (fig. 1, 2). In Fig. 1, Zone 6, Sector 4, 83% of all positive slides were sent back to the Zone Chief within eight days after slide taking. Seventy-three percent of the positive cases had undergone radical treatment by the 12th day and 93% were treated by the 16th day. This demonstrates graphically an efficient reception and disposal of slides as well as rapid follow-up by the sector chief.

A less than adequate curve is presented in Fig. 2. Here at Zone 2, Sector 3, only 23% of the positive results had been forwarded to the Sector Chief by the twelfth day. By the time 20 days had elapsed only 59% of all the positive cases had been identified to the Sector Chief. The data for radical treatment are equally unsatisfactory. Only 9% of the positive cases had been treated by day 20 after the slide had been taken.

In order to examine more closely the untimely delay the laboratory log books, for the month of September 1966, were studied at the Zone 2 Laboratory. The time interval between the taking of the slide and reception of the slide in the laboratory was determined for Sector 3 as well as the length of time the slide was in the laboratory before a report was sent to the sector office. Fig. 3 shows these data for September 1966. Only 60% of all the slides had been received within 20 days from slide taking. That delays in the laboratory were not prolonged can be seen in the sister graph; 100% of the slide results had been sent by the eighth day.

Therefore, the reason for delays seemed to be the forwarding of slides to the zone laboratory by the sector chief. The usual field routine is as follows: (a) slides are delivered to the squad chief by the house visitor, (b) slides are collected by the sector chiefs and forwarded to the zone laboratory. At the Zone 2 laboratory, the Chief Microscopist asserted that the reception of slides was indeed his main problem. Often he did not have enough work to keep the microscopists busy until the 20th to 25th of the month when a veritable flood of slides arrived into the laboratory. This meant that microscopists were obliged to do the bulk of the work within a few days.

Similar analyses done at three other zone laboratories demonstrated that when delays were present, the laboratory was usually not at fault but, rather, a poor forwarding of slides from the field was to blame.

FIGURE 1

TIME INTERVALS POSITIVE CASES
REGION 3 ZONE 6 SECTOR 4
1966 – ACD

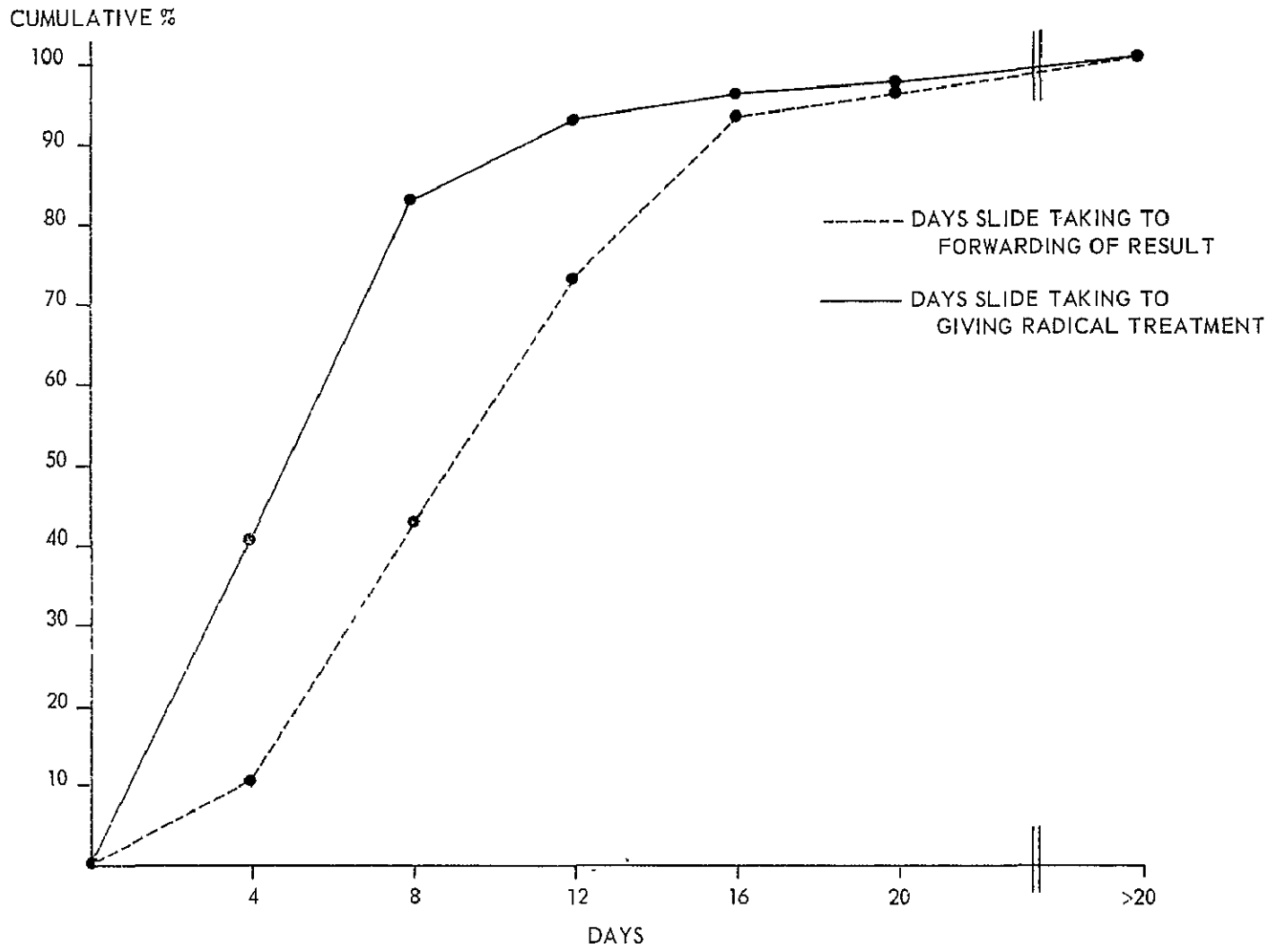


FIGURE 2

TIME INTERVALS POSITIVE CASES
REGION 3 ZONE 2 SECTOR 3
1966 – ACD

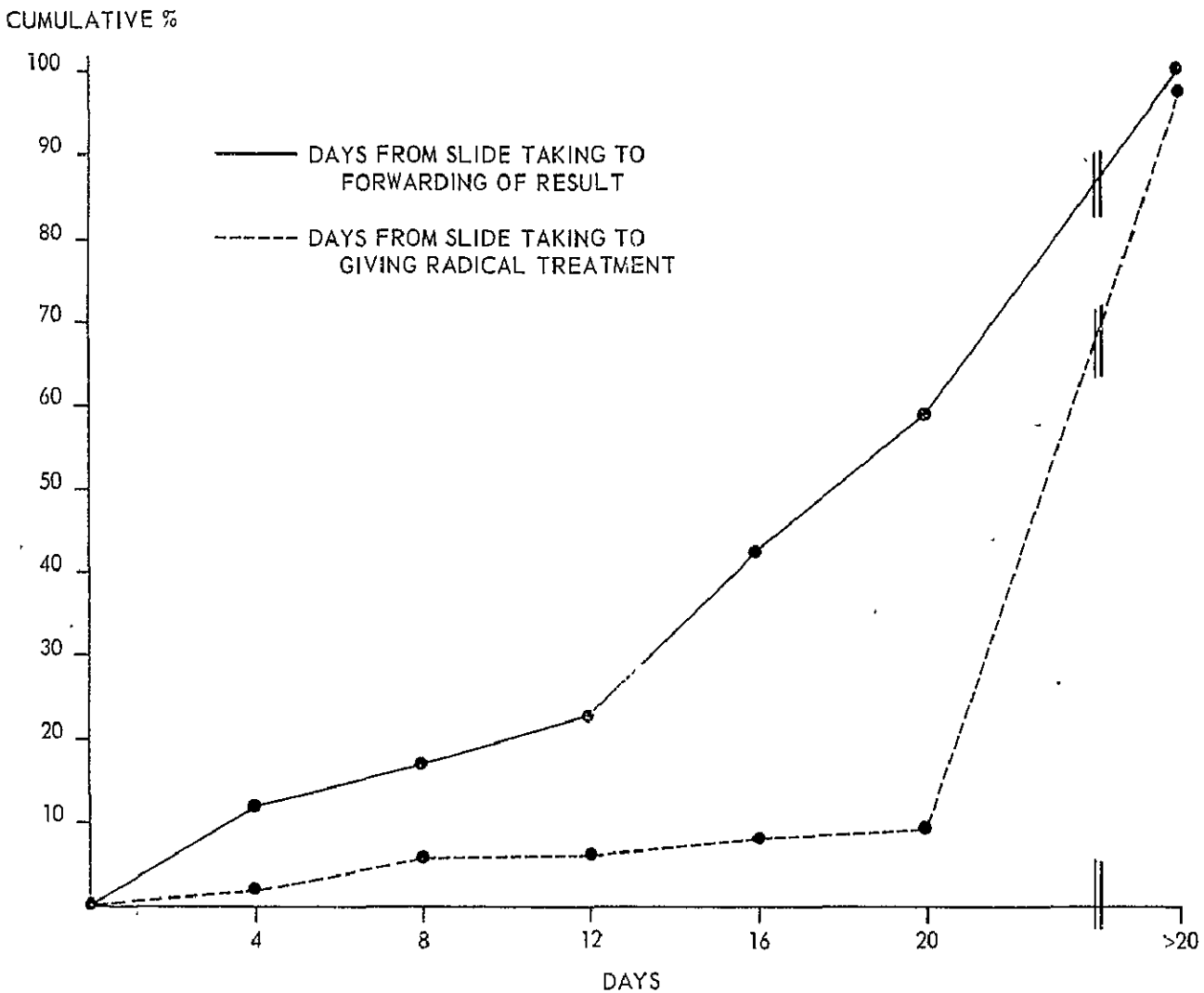
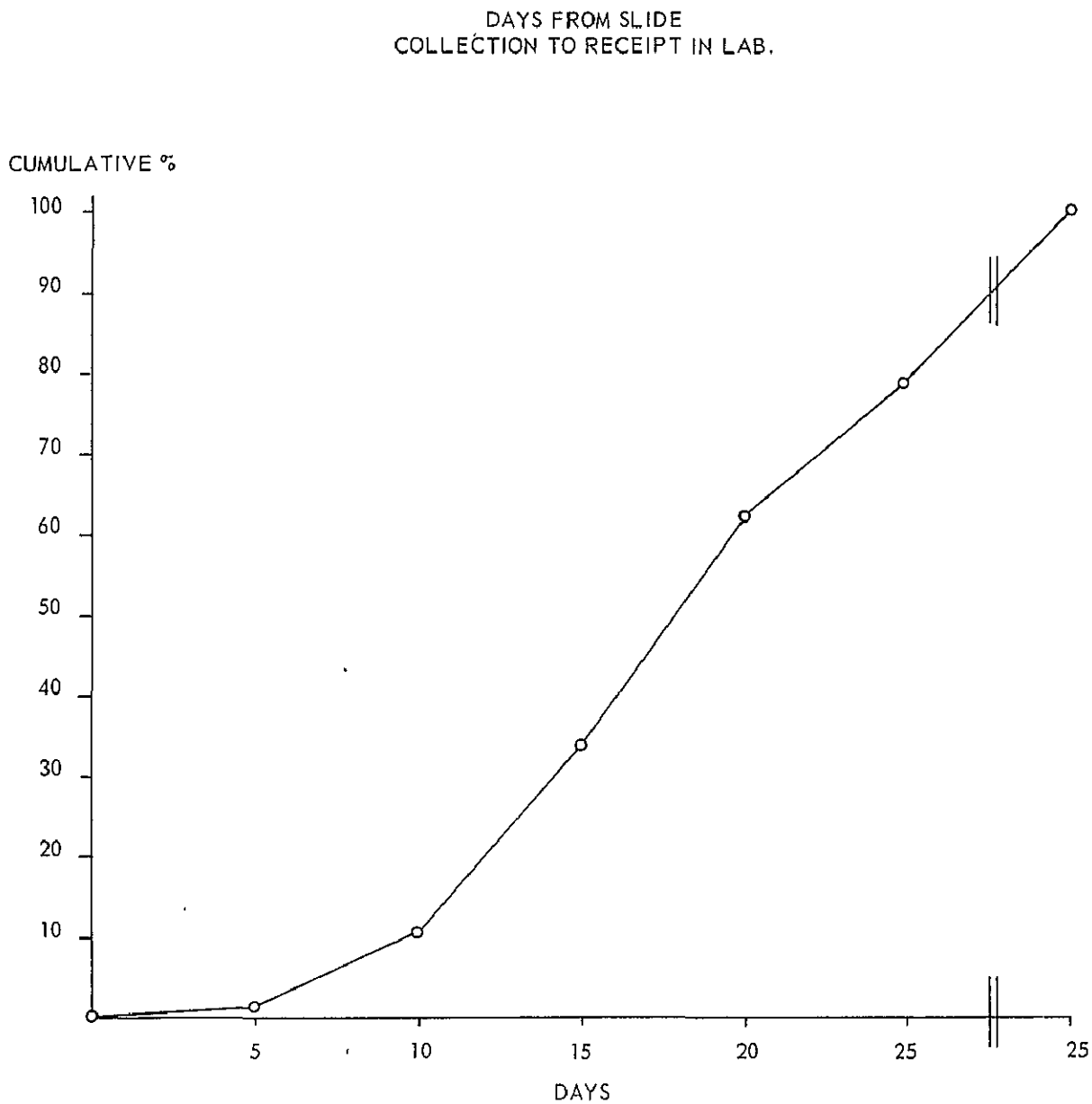
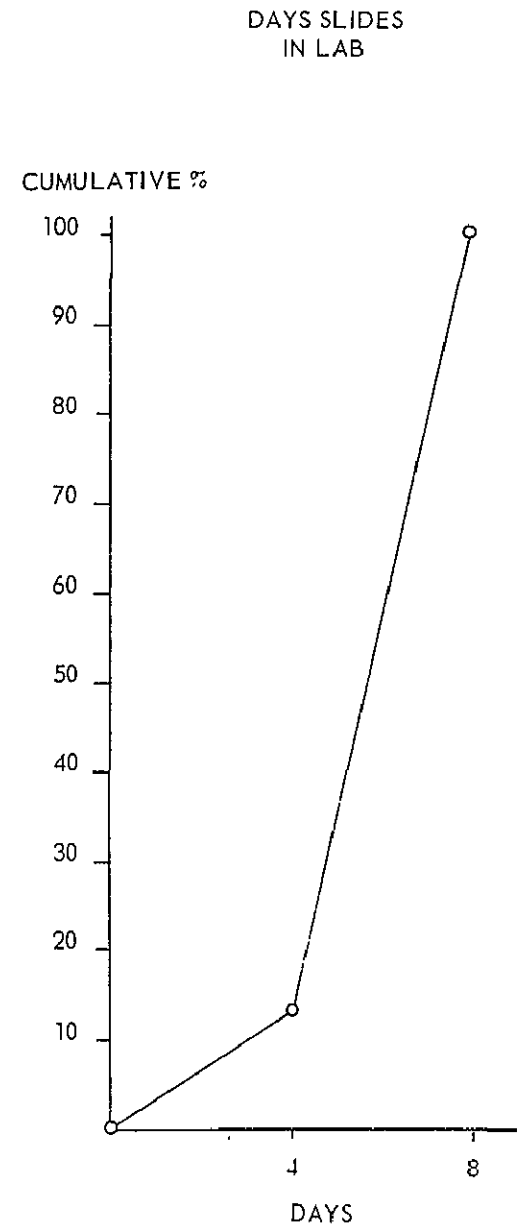


FIGURE 3

REGION 3 ZONE 2 SECTOR 3





3. Evidence of Bias

Age and sex of all positive cases in 1966 detected by ACD surveillance was compared to the age and sex of persons from whom slides were taken. This was done in order to determine whether specific groups were being missed in the surveillance network.

In each of the sectors visited, MS2 forms for 1966 were obtained. From these records the age and sex distribution of persons from whom slides were taken were determined for the months of May, September, and October. Only those slides taken because of fever or history of fever were included. September was chosen as a "rainy" month and October represented the first "dry" month. May was randomly selected.

The results are presented in Table 11.

TABLE 11
AGE AND SEX DISTRIBUTION OF ACD SLIDES AND POSITIVE CASES

			Zone 1 S8		Zone 2 S3		Zone 4 S6		Zone 6 S4	
Age Group	Sex	Percent Pop.	% slides taken	% + cases	% slides taken	% + cases	% slides taken	% + cases	% slides taken	% + cases
<1	M	1.3	1.6	0.0	0.8	0.0	0.9	0.0	0.1	0.0
	F	1.2	1.5	0.0	0.6	0.0	0.8	0.0	0.05	0.0
12-24 mos.	M	1.8	3.4	0.0	1.1	1.8	1.6	0.0	0.3	0.0
	F	1.8	2.4	2.2	1.4	.9	1.7	0.0	0.4	0.0
2-10	M	13.1	14.9	11.6	16.4	5.4	17.8	5.5	10.3	5.5
	F	12.8	15.3	8.0	13.1	5.4	15.8	2.7	8.7	2.7
11-20	M	12.2	6.6	23.9	7.4	18.0	6.1	37.9	8.4	37.9
	F	11.9	7.9	8.0	8.2	4.5	6.0	2.2	5.2	2.2
21-30	M	7.9	5.9	22.5	6.7	16.2	5.0	29.1	7.7	29.1
	F	8.4	6.5	7.2	7.3	7.2	6.7	1.6	4.7	1.6
31-40	M	5.7	4.2	7.2	8.3	16.2	4.1	8.8	13.3	8.8
	F	5.8	5.6	2.9	5.9	2.7	7.2	1.1	6.6	1.1
41-50	M	3.8	3.9	2.9	6.6	5.4	4.4	6.0	10.4	6.0
	F	3.7	5.3	.7	4.1	0.0	6.2	1.6	6.1	1.6
>50	M	4.0	6.3	1.4	6.6	12.6	6.0	2.2	8.6	2.2
	F	4.4	8.4	1.4	5.3	3.6	9.7	1.1	9.0	1.1
Total Numbers			3097	137	4363	111	2924	47	3575	92

Zone 1 Sector 8 showed the best overall sampling. The low level of sampling the less than one age group is particularly impressive in Zone 6. Therefore, the absence of positive cases in this age group may simply reflect poor sampling.

However, the most striking finding is the definite preponderance of male cases in the 11-30 age group. This occurred despite relatively even sampling. Certainly this finding strengthens the notion that the working male is at greater risk. This may occur because of his greater mobility in search of work or because of his occupation.

4. Epidemiologic Investigation

The responsibility of insuring that radical treatment is given to positive cases rests upon the sector chief. Early treatment of positive cases is important since these cases are reservoirs of infection liable to spill over into the community. Delays in the institution of radical treatment were previously commented upon when discussing time intervals.

MS8 forms in 5 sectors were reviewed for completeness of epidemiologic action. Table 12 summarizes the data extracted:

TABLE 12
SUMMARY OF EPIDEMIOLOGIC INFORMATION (POSITIVE CASES - ACD - 1966)

Zone	Sector	No. Cases by ACD	No. with Radical Treatment	Percent w/Radical Treatment	Moved - No Follow-up	No Contact, No Follow-up	Positive on Follow-up	
							No.	Percent
1	8	139	108	78.3	28	3	50	46.3
1	10	79	52	65.8	7	20	11	21.2
2	3	111	66	59.5	18	27	4	6.1
4	6	47	34	72.3	5	8	8	23.5
6	4	91*	83	90.2	5	3	29	34.9

* Based on an analysis of one-half of 182 positive cases.

The percent of persons receiving radical treatment ranged between 59 and 90 percent. Sector chiefs volunteered that there were simply too many cases for investigation. While this attitude is understandable, it was interesting to note that while Zone 6, Sector 4, had the largest number of cases, the percentage distribution receiving radical treatment was also the highest.

The number of positive slides on follow-up was disturbingly high, however, and although this may reflect the problem of chloroquine-resistant malaria in Thailand, it cannot be regarded as the sole answer while the total efficiency of the system remains in doubt.

The team also noticed the tendency of sector chiefs on investigation forms to attempt to label all or almost all cases as "imported". It was generally felt that when a case was so labeled it did not present such a pressing an obligation as an "indigenous" case. Further, no attempt appears to be made to contact neighboring sector chiefs about so-called "imported" cases.

E. LABORATORY SERVICES

1. Facilities and Slides

The laboratory facilities in the four sector offices were found to be well maintained. All the microscopes were checked and found to be in good working order. Thirty slides were then selected at random and evaluated for thickness, debris, dehemoglobinization, and stain. Table 13 summarizes the findings.

TABLE 13
REGION 3 LABORATORY & SLIDE EVALUATION

Zone	(1966) Slides examined per microscopist per day	General Lab Condition	# Slides Analyzed	No. Slides Unacceptable because of				Total unacceptable for one or more reasons	
				Thickness	Debris	Dehem	Stain	No.	Percent
1	59.0	Good	31	2	3	0	0	4	12.9
2	68.9	Good	31	5	1	0	0	5	16.1
4	59.5	Good	30	0	0	0	0	0	0
6	66.8	Good	33	0	0	0	0	0	0
Totals	63.5		125	7	4	0	0	9	7.2

In two of the sector laboratories all 30 slides were found to be acceptable. However, form L5C, to be used specifically to report poor blood smears, was sparingly used. In the sector with the poorest slides only six of these forms had been issued during the entire year. In general, nevertheless, the efficiency and competence found in the laboratories was impressive.

2. Slide Checking

NMEP protocol requires that 10% of all negative slides be checked and that all positive slides be verified. Table 14 charts the extent of slide checking in Zones 1, 2, 4, and 6 of Region III.

TABLE 14
EXTENT OF SLIDE CHECKS - REGION III - ZONES 1,2,4, & 6

			1966													
				NEGATIVE SLIDES						POSITIVE SLIDES						
Zone	Total Slides Examined	Total Pos. Slides	S.P.R./100	# Slides checked at region	Percent	# Slides checked at NMEP	Percent	Total No. Negatives Checked	Percent	No. Slides checked at region	Percent	No. Slides checked at NMEP	Percent	Total No. Pos. checked	Percent
1	136,537	2778	2.0	12,074	9.0	1264	0.9	13,338	9.9	2122	76.4	623	22.4	2745	98.8
2	126,917	3762	3.0	10.091	8.2	1159	0.9	11,250	9.1	2795	74.3	858	22.8	3653	97.1
4	129,241	3130	2.4	10,312	8.2	1183	0.9	11,495	9.1	2003	64.0	689	22.0	2692	86.0
6	106,772	2706	2.5	8,783	8.4	950	0.9	9,733	9.3	1945	71.9	554	20 5	2499	92 4

All of the four sectors had slightly less than 10% of the negative slides checked; between 86 and 99% of all the positive slides were being checked.

In the Thailand MEP, two independent checking systems are used. A sector sends about 9% of all its negative slides to the regional laboratory and 1% of its slides to NMEP headquarters in Bangkok for checking. About 75% of the positive slides are sent to the region and 25% are forwarded to NMEP.

The results of this tandem checking system are presented in Table 15.

TABLE 15
RESULTS OF SLIDE CHECKS - REGION III - ZONES 1,2,4, & 6

	REGIONAL LAB CHECK						NMEP CHECK					
	Negatives			Positives			Negatives			Positives		
Zone	No. of Slides Sent	No. False Neg.	% False Neg.	No. of Slides Sent	No. False Pos.	% False Pos.	No. of Slides Sent	No. False Neg.	% False Neg.	No. of Slides Sent	No. False Pos.	% False Pos.
1	12,074	8	0.07	2122	0	0.00	1264	1	0.08	623	0	0.00
2	10,091	47	.47	2,795	26	0.93	1159	14	1.21	858	0	0.00
4	10,312	21	.20	2003	3	0.15	1183	6	0.51	689	0	0.00
6	8,783	35	0.40	1945	1	0.05	950	4	0.42	554	1	0.18
Total	41,260	111	0.27	8865	30	0.34	4556	25	0.55	2724	1	.04

Results from both checking systems operating independently showed in general, a higher number of false negatives found at NMEP than at the Region III laboratory. To further document this observation the results of NMEP checks on the Region III laboratory were tabulated for 1966 (Table 16).

TABLE 16
RESULT OF SLIDE CHECKING OF REGION III
LABORATORY BY NMEP - 1966

	NEGATIVES			POSITIVES		
Laboratory	Slides Sent	False Neg.	Percent False Neg.	Slides Sent	False Pos.	Percent False Pos.
Region III	6185	12	0.19	1220	9	0.74

At the Region III laboratory a false negative rate of 0.27% had been found in a sample of slides reviewed from the 5 zone laboratories. When the requisite sample of slides from the Region 3 Laboratory examined at the NMEP, the false negative rate was 0.19%. Thus, the addition of these two figures gives an overall false negative rate of 0.45%. Therefore, 40% of these positive slides were missed at the regional laboratory.

F. SUPERVISION

Responsibility for supervision rests in all of the departments of the NMEP. Thus, for every 2 or 3 house visitors one squad chief is assigned. The sector chief oversees the squad chiefs and the sector chief is in turn responsible to the zone chief.

Squad chief supervision was checked by determining the number of times a house visitor was seen. In four sectors surveyed all the signatures of the squad chief were up to date in the MS1A forms. However, when in the field it was soon obvious that a signed form did not necessarily mean supervision. On occasion house cards had been signed by the squad chiefs where no visits by house visitors had been made for months. Maps were usually not kept up to date. In most instances whenever faulty performance of house-visitors was found the squad chief was equally unaware not only of what was expected of him but also of his house visitors.

The Administrative Order Book number 6 was reviewed in each of the zones and sectors visited. In this book recommendations and criticisms of the area being visited were recorded. Tables 17 and 18 summarize the findings in the sector and zone offices respectively.

TABLE 17
SECTOR OFFICE ADMINISTRATIVE ORDER BOOK NO. 6 - 1966

Zone	Sector	Number Inspections	Origin of Inspection		
			Zone	Region	NMEP
1	8	2	1		1
2	3	4		3	1
4	6	4	3	1	
6	4	2		2	
Total		12	4	6	2

TABLE 18
ZONE ADMINISTRATIVE ORDER BOOK NO. 6 - 1966

Zone	Number Inspections	Origin of Inspection	
		Region	NMEP
1	4	1	3
2	7	5	2
4	4	2	2
6	8	6	2
Total	23	14	9

Of particular interest is the obvious lack of zone supervision of the sector offices. One-half of the visits to sector offices were made by individuals from the Regional Office. The supervision of the zone office was far more complete. Nevertheless, the key to the success or failure of the MEP in Thailand is the sector chief. In areas where he was competent and industrious, there were rarely problems; where this was not the case the shortcomings were reflected throughout the sector chief's sphere of influence. Certainly, because of the key role they play in the NMEP, sector chief's activities must of necessity be closely monitored.

APPENDIX TABLE 1
REGION 3 - ABER, API & SPR RESULTS
1963 - 1966

Province	District	1966 Pop.	ABER 1963	ABER 1964	ABER 1965	ABER 1966	API 1963	API 1964	API 1965	API 1966	SPR 1963	SPR 1964	SPR 1965	SPR 1966
Khonkaen	Phuvieng	62,471	9.6	12.1	14.89	12.76	1.9	2.4	0.9	1.0	1.96	1.98	.66	.84
	Nongrua	51,011	23.1	12.7	15.42	14.48	3.7	2.7	2.1	2.4	1.60	2.16	1.32	1.70
	Manjakiri	60,591	12.1	20.7	16.63	14.47	1.6	2.1	1.2	.5	1.32	1.00	.75	.37
	Chonnabot	31,051			14.42	11.31			0.4	.3			.34	.34
	Nampong	107,640	10.9	11.2	13.31	14.50	1.9	2.2	1.5	1.3	1.75	2.00	1.15	.93
	Kranuan	47,626	6.7	10.8	10.70	12.59	1.3	3.3	2.1	1.5	1.92	3.00	2.00	1.22
	Muang	200,326	9.3	12.3	12.10	10.81	.69	.66	0.8	.4	.75	.54	.70	.45
	Banphai	102,755	14.0	12.7	11.18	10.97	.6	.87	0.5	.4	.45	.68	.47	.32
	Phol	101,467	17.4	13.7	13.35	14.59	1.8	1.5	1.2	.9	1.0	1.12	.9	.65
	Nongsonghong	47,487	15.8	14.3	15.06	14.22	2.6	2.9	2.5	1.3	1.67	2.04	1.7	.94
Totals		812,425	12.3	13.1	13.23	12.70	1.4	1.7	1.2	.9	1.18	1.28	0.915	.718
Udornthani	Muang	204,624			11.13	9.54			1.8	0.5			1.6	.62
	Kumpavapee	154,237			14.69	13.02			1.2	0.6			.83	.51
	Nonsang	46,473			20.96	15.49			3.5	0.7			1.7	.47
	Sribunruang	46,845				16.28				0.8				.49
	Nongharn	114,075			9.46	14.27			1.7	0.7			1.85	.55
	Bandung	28,726				11.97				1.4				1.2
	Phen	62,972				13.63				0.3				.22
Totals		657,952			12.78	12.12			1.8	0.6			1.40	.54
Nongkhai	Sungkom	7,695			33.94	25.8			33.7	1.7			10.0	9.2
	Srichiengmai	5,066			22.11	21.47			6.2	8.6			2.89	4.1
	Tha-bor	47,990				11.47				0.2				.27
	Muang	94,602				10.66				0.4				.45
	Phomphisai	41,682			24.25	21.93			33.5	26.8			13.8	12.4
	Bungharn	55,140			22.99	19.55			27.9	23.1			12.2	11.6
	Seka	31,575			23.20	18.72			16.8	10.5			7.3	5.6
Totals		331,044			24.09	12.46			27.0	8.9			11.2	7.18
Sakolnakorn	Muang	135,825				15.12				2.6				1.7
	Kusumarn	19,921				19.78				1.9				.97
	Sawang Daen Din	107,315			18.37	16.60			5.8	4.5			3.2	2.7
Totals		263,061			18.37	14.52			5.8	3.1			3.2	2.1

APPENDIX TABLE 1 - CONTINUED

Province	District	1966 Pop.	ABER 1963	ABER 1964	ABER 1965	ABER 1966	API 1963	API 1964	API 1965	API 1966	SPR 1963	SPR 1964	SPR 1965	SPR 1966
Kalasin	Muang	79,182			11.18	13.74			2.3	0.7			2.06	.56
	Kalamasai	69,658	8.1	11.3	11.27	11.46	2.6	2.0	1.5	1.1	3.26	1.8	1.33	1.04
	Yangtalad	99,169	8.9	9.8	10.26	10.40	1.8	1.4	1.2	0.8	1.76	1.43	1.24	.75
Totals		248,009	8.6	10.5		11.76	2.1	1.7		0.8	2.48	1.60	1.54	.76
Mahasarakham	Chiengyuen	55,104	9.4	18.1	18.31	20.00	1.5	1.7	1.9	1.6	1.6	.96	1.08	.83
	Kantharavichai	45,077	9.0	12.8	17.08	20.12	3.9	3.3	3.1	2.3	4.26	2.54	1.87	1.17
	Muang	75,458	9.8	14.7	10.39	13.20	1.7	1.0	.6	.6	1.6	.70	.60	.48
	Kosumpisai	70,328	11.4	14.7	11.22	10.69	1.2	.86	.6	.7	1.0	.58	.58	.718
	Borabue	81,125	8.8	12.3	11.47	12.68	1.6	1.6	.7	1.0	1.78	1.33	.68	.80
	Na-Chuek	37,877	12.2	15.5	20.01	11.30	2.4	1.6	1.9	1.5	2.0	1.04	.95	1.35
	Phayakkhapnumpisai	78,584	8.5	13.4	11.52	11.94	2.3	2.7	2.0	4.5	2.64	2.02	1.8	3.8
	Vapipathu	79,792	10.0	15.9	12.68	12.54	3.6	3.1	1.7	2.6	3.54	1.95	1.4	2.1
Totals		523,345	9.7	14.5		13.68	2.2	3.0		1.9	2.26	1.35	1.14	1.4
Ubolrajthani	Muang	83,379				10.26				0.1				.18
	Varichamrab	110,280				10.45				.2				.24
	Trakan Phutphom	75,171				17.27				2.2				1.26
	Phana	27,617				14.78				.7				.55
	Amnat Charoew	119,026			13.33	12.62			5.0	.6			3.82	.50
	Loengnoktha	60,480				18.29				.8				.46
	Yasothon	72,302	10.5	8.1	8.76	11.79	3.6	2.3	1.8	.3	3.42	2.94	2.1	.27
	Kutchum	34,544	8.6	12.0	10.39	10.46	5.6	.62	5.0	.7	6.6	5.2	4.9	.75
	Khamchuenkao	38,767	6.2	9.1	12.26	16.35	2.8	4.6	2.4	.7	4.49	5.1	2.0	.47
	Pa-tiew	19,748				3.6				.05				.38
	Mahachawachai	48,246	8.9	10.9	17.17	12.97	6.7	9.7	3.6	.3	7.5	8.8	2.1	.29
	Khuangnai	65,598			13.07	11.82			1.7	.8			1.38	.71
	Muangsamsip	61,604			13.31	12.02			4.2	.5			3.22	.47
Totals		816,762	8.7	9.5	11.38	11.71	4.3	5.2	3.1	0.6	5.0	5.45	2.76	.52
Roi-Et	Atsqmat	40,470	8.8	12.7	9.46	13.37	7.8	6.9	8.5	3.0	8.0	5.4	9.0	2.26
	Phanomprai	59,927	11.4	17.3	13.70	19.58	11.8	14.1	16.2	4.8	10.3	8.15	11.8	2.44
	Suwannaphum	84,308	10.0	12.3	9.07	10.43	6.6	7.4	7.8	1.5	6.5	6.05	8.65	1.53
	Kasetvisai	46,937	8.9	13.4	16.13	21.47	5.2	5.0	4.6	1.3	5.9	3.72	2.90	.62
	Prathumrat	31,476	8.9	13.7	13.90	20.45	6.8	3.4	3.9	0.9	9.2	2.50	2.86	.45
	Chaturapakpimarw	47,152	10.9	17.9	15.12	20.59	5.7	6.3	6.3	2.2	5.2	3.52	4.2	1.07
	Muang	116,667	8.1	7.5	6.69	11.54	4.1	4.2	3.7	1.8	5.0	5.55	6.4	1.59

APPENDIX TABLE 1 - CONTINUED

Province	District	1966 Pop.	ABER 1963	ABER 1964	ABER 1965	ABER 1966	API 1963	API 1964	API 1965	API 1966	SPR 1963	SPR 1964	SPR 1965	SPR 1966
	Thavatchburi	67,704	10.5	9.2	7.54	10.57	7.0	5.7	4.6	1.5	6.6	4.9	6.21	1.45
	Selaphum	70,481	10.4	9.7	7.82	11.59	7.3	6.9	8.4	3.0	7.0	7.0	10.8	2.61
	Phonthong	100,871			6.98	13.63			7.2	1.8			10.4	1.38
	Nongpok	19,632			11.52	13.84			18.4	1.2			16.0	.88
Totals		684,625	9.8	11.7	9.24	14.20	6.6	6.6	6.8	2.1	6.75	5.60	7.35	1.52

APPENDIX TABLE 2

PERCENTAGE OF HOUSES MISSED AND INCOMPLETELY SPRAYED, AND Gm/ CAPITA BY DISTRICT - 1964-1966

Province	District	% Missed Houses			% Incompletely Sprayed Houses			Gm/Capita		
		1964	1965	1966	1964	1965	1966	1964	1965	1966
Khonkaen	Muang	1.4	7.2	11.0			3.50	105.7	122.9	122.5
	Nongrua	.3	3.3	2.7			.03	119.9	103.4	96.3
	Chumpae	.9	2.2	5.3			.50	108.6	109.1	111.7
	Nampong	5.1	4.2	3.7			1.02	148.4	99.8	127.9
	Kranuan	1.1	3.4	7.3			3.10	71.6	104.1	111.0
	Banphai	-	3.7	12.5			.69	-	127.8	168.6
	Phol	-	1.9	2.9			.24	-	111.7	152.4
	Nongsonghong	-	1.9	3.6			.39	-	105.0	148.4
	Phuvieng	2.3	3.4	5.8			5.08	104.3	107.3	112.5
	Manjakiri	0.3	1.9	2.7			0.00	116.9	100.3	97.3
	Chonnabot	-	-	8.1			1.51	-	-	-
Loei	Muang	4.3	5.6	5.3			.01	147.1	150.6	134.6
	Chiangkan	1.4	3.1	5.4			0.00	127.2	139.7	167.4
	Dansai	1.1	2.9	3.5			.03	125.9	135.8	130.7
	Thali	1.2	5.3	7.8			0.00	139.5	170.3	179.9
	Wangsaphung	1.2	7.2	6.7			0.00	119.5	133.2	114.5
	Pukradung	.6	5.2	8.8			0.00	113.0	132.6	112.5
Udornthani	Muang	3.0	.7	1.9		2.87	6.04	108.3	118.8	130.5
	Kumphawapee	.2	2.3	.6		1.01	1.49	116.6	118.1	141.8
	Nonchan	1.1	0.0	2.9		3.64	1.79	101.9	113.4	127.2
	Bandung	.4	1.0	3.3		2.75	4.53	96.7	99.4	100.3
	Noncbualanphue	3.4	1.8	3.0		0.00	1.66	88.9	104.1	123.9
	Nonsang	2.6	1.3	.6		0.00	4.64	106.7	112.8	124.1
	Banphu	.8	1.6	1.7		.84	1.43	118.6	109.2	125.7
	Phen	0.2	2.1	1.1		1.11	.62	131.3	122.4	168.5
	Naklang			2.3			1.91			107.8
	Sribunruang			.6			2.63			125.3
Nonghai	Muang	2.0	0.0	3.6		4.79	4.77	104.2	120.8	116.9
	Thabor	.3	2.4	2.9		8.12	10.82	101.0	91.3	144.4
	Bunghan	3.1	10.8	3.8		4.50	3.81	163.9	118.9	147.3
	Phonphisai	3.5	2.8	3.6		11.29	3.28	123.3	126.4	119.4
	Sichiangmai	.7	1.8	7.8		16.20	10.30	107.8	110.1	103.7
	Seka	1.8	7.8	2.5		2.36	5.61	104.6	136.2	135.4
	Sungkom			4.8			14.11			138.1
Sakonnakhon	Muang	0.1	2.1	8.0		1.47	2.46	126.7	137.6	132.9

APPENDIX TABLE 2 - CONTINUED

Province	District	% Missed Houses			% Incompletely Sprayed Houses			Gm/Capita		
		1964	1965	1966	1964	1965	1966	1964	1965	1966
	Phanna Nikom	0.2	1.0	3.2		1.74	.96	127.9	142.8	135.3
	Warichta Phum	0.6	1.9	1.9		5.81	1.66	116.2	128.5	134.6
	Wanon-Niwat	0.4	1.3	4.4		3.17	0.00	111.0	136.1	126.1
	Sawang Daen Din	0.04	.3	0.4		.73	1.85	118.9	127.9	125.9
	King Kut Bak	0.6	1.6	5.7		.64	2.02	101.1	113.3	102.2
	King Kusuman	0.2	1.7	7.5		.91	1.10	119.4	139.7	108.7
	King Abat Amauoi	0.5	1.7	6.4		2.68	3.21	122.7	142.3	132.9
Nakomphanon	Muang	.9	3.9	7.2		2.75	4.17	123.4	126.7	113.3
	Tha Uthen	1.4	3.2	4.3		1.72	1.63	117.7	128.5	118.3
	Ban Phaeng	.8	2.8	7.4		1.14	.45	102.3	125.8	120.8
	That Phanom	.5	2.8	3.5		1.40	2.71	124.0	105.2	141.8
	Nakae	.5	3.0	3.9		.65	.39	124.5	120.5	130.9
	Mukdahaw	.6	1.0	3.4		.86	.61	11716	131.4	131.7
	Si Songharn	.2	3.1	4.1		.31	.05	116.6	121.2	152.2
	Knam Chahee	.5	1.9	3.4		1.77	1.23	115.1	142.6	134.4
	King Prapak	-	-	4.6		-	.33	-	-	118.5
	King Dontan	.7	1.9	0.0		.89	.90	109.3	119.9	124.7
Mahasarakam	Muang		2.4	4.0		.02	.64		111.1	133.1
	Kosumpisai		3.0	4.2		.14	.02		138.1	139.9
	Kantharawichai		1.2	5.4		.18	1.26		120.6	124.4
	Borabu		2.2	7.0		.94	.72		106.3	121.2
	Phayakkhapnumphisai		2.8	2.4		.23	.46		112.9	136.6
	Vapipathum		2.0	4.5		.11	.01		119.0	130.1
	Chiangyun		.9	9.4		.31	.61		120.9	104.0
	Nachuak		.4	12.4		.65	1.45		121.8	120.8
Kalasin	Muang	0.6	1.4	2.0		3.56	3.96	96.2	93.9	104.8
	Kamalasai	0.3	.1	2.1		2.69	1.81	109.0	98.0	88.0
	Sanatsakhan	1.0	.8	1.1		2.12	1.17	108.0	109.4	137.3
	Kuchinarai	0.1	0.0	.05		1.21	.10	120.8	123.5	121.2
	Yangtalad	0.09	.3	2.0		1.45	.47	117.3	111.2	130.0
	S. Thakhantho	0.6	1.0	2.7		1.26	2.27	114.3	105.7	110.2
	S. Somdet		1.8	3.4		2.73	1.73		119.2	134.5
Ubonrachathani	Muang	2.4	7.0	2.4		6.62	3.57	120.6	110.7	80.0
	Warin Chamrap	3.5	0.0	4.2		15.89	13.27	128.5	114.0	118.5
	Mahai Chawachai	1.0	5.1	2.3		2.91	.05	154.6	153.1	122.7
	Kuang Nai	.2	5.5	4.4		5.01	0.00	123.6	132.3	166.6

APPENDIX TABLE 2 - CONTINUED

Province	District	% Misses Houses			% Incompletely Sprayed Houses			Gm/Capita		
		1964	1965	1966	1964	1965	1966	1964	1965	1966
	Khakhan Kaeo	2.2	6.7	5.1		2.65	1.46	134.9	150.9	132.4
	Muang Samsip	1.4	5.9	6.2		5.93	0.00	129.0	115.4	106.3
	Amnat Charoen	0.8	4.6	1.5		3.17	4.24	116.4	118.1	131.6
	Phana	.4	1.6	9.1		1.35	.55	97.8	107.2	112.8
	Trakan Phutphom	.7	.7	2.6		1.36	1.65	142.9	88.4	103.0
	Loene Noktha	1.0	0.0	6.2		3.33	2.88	137.9	125.1	147.5
	Detudom	3.6	1.9	1.7		1.61	4.36	129.7	121.9	123.3
	Bun Tharik	.7	5.5	1.7		5.46	1.82	112.7	140.2	170.1
	Phibun Mangsaham	2.8	.61	2.6		4.91	3.33	111.5	110.8	172.5
	Khong Chiam	2.5	3.2	4.3		3.02	2.57	148.8	113.5	97.4
	Khemarat	1.6	0.0	3.3		2.24	.84	129.6	111.9	107.3
	Chanumarn	3.5	0.0	-		1.03	0.00	135.5	113.0	114.0
	Bandarn	1.4	4.1	3.0		2.97	1.84	159.5	116.7	103.2
	Yasothon	-	5.1	9.2		3.83	8.5	159.5	146.8	147.0
	Kutchum	-	9.8	6.3		8.86	3.71	-	151.7	142.1
Roi Et	Muang		2.3	2.1		.77	3.94		129.4	118.0
	Kasetwisai	2.6	2.0	0		.22		101.0	116.5	
	Chaturaphakphiman		2.3	2.2		.45	.08		103.4	122.8
	Thawatchaburi		1.7	3.4		.84	.59		98.6	124.1
	Phanomphrai		3.0	4.8		.54	1.44		133.7	116.5
	Selaphum		2.8	0.2		.61	.15		108.8	132.2
	Suwannaphum		2.8	2.2		.08	.55		113.9	128.4
	Astamat		3.1	6.3		.10	1.83		114.5	121.4
	Phonthong	0	1.9	.7		.60	.57	100.1	110.4	120.9
	S. Wongpok	-	1.9	1.0		-	1.02		-	104.2
	S. Pathumrat		4.2	4.2		.04	.65		95.8	151.0

REGION 4 SURVEY

INTRODUCTION

The data presented and the observations that follow are based on a field survey made from March 10, 1966 to March 22, 1966. The survey was made predominantly at zone and sector levels after a preliminary study of data at the Regional Headquarters at Songkhla.

Region 4 consists of the lower two thirds of the Thailand peninsula and has common borders with Burma to the northwest and Malaysia to the south. There are two ranges of forested hills, one on the Burma border and the other running north and south in the lower third of the Region. There are two coastal plains, the eastern plain being the larger of the two. The total estimated population in 1966 was 4,014,019 including several island communities, the largest being on Phuket off the west coast. Rice farming, rubber planting and tin mining are the main occupations.

A. CURRENT STATUS OF MALARIA ERADICATION

Surveillance through ACD and PCD started in 1963 in two island areas of Region 4. During the past 4 years this has been gradually extended to cover 54 districts containing 2,390,140 persons or 59.5% of the total estimated population of 4,014,019. In May 1967 a further 26 districts will come under surveillance and by the end of 1967 only 9 districts in the Region will be without this cover.

The serial annual parasite incidences (API), Slide Positivity Rates (SPR), and annual blood examination rates (ABER) for 54 districts in Region 4 are presented in Table 1 (See also Figure 1). In 47 of these districts the data for at least two years of surveillance permits examination of trends. Between 1965 and 1966 the SPR and API concurrently decreased in only 13 of the 47 districts.

The data presented in Table 1 were calculated at the Region 4 Headquarters in Songkhla. Only in one of the 3 zones visited, namely Zone 2, were the API, SPR, and ABER being calculated at the zone level. When those zone results were compared with the indices for the same districts as those which had been calculated at the regional level, they differed in 31 out of 34 instances. Further, the difference between the regional and zone records was such in the two districts of Ranode and Muang as to give conflicting results regarding the actual progress towards malaria eradication.

The data from the Region as presented are exactly as they appear in the Songkhla Headquarters and, intentionally, any mathematical inconsistencies have not been corrected.

In none of the seven sector offices visited were API, SPR, and ABER being calculated.

In districts under spray cover but without surveillance, annual malariometric surveys are used to assess the effectiveness of spray operations. The survey techniques and results were analyzed in Zone 2. This showed that although the techniques and locations of the surveys did not change they were unfortunately being conducted at different seasons of the year. The variation in the monthly distribution of cases indicated that the annual surveys in 5 neighboring zones were not comparable.

The total number of cases in 1966 were plotted by month for the five zones. In Zone 1 and 2, there was a peak of transmission between January and March. Zone 1 and 3 also showed the summer peak of transmission typical of other regions in Thailand. Zones 4 and 5 had a low level

TABLE 1
ANNUAL PARASITE INCIDENCE: SLIDE POSITIVITY RATE AND
ANNUAL BLOOD EXAMINATION RATE (BY DISTRICT)
Region 4 - (Songkhla)
(Regional data - Zone data in parentheses when available)

Zone	Sector	District	1966 Pop.	API 1963	API 1964	API 1965	API 1966	SPR 1963	SPR 1964	SPR 1965	SPR 1966	ABER 1963	ABER 1964	ABER 1965	ABER 1966
1	4	Panarch	25,860		3.5	3.5	6.1		1.8	3.3	6.9		6.1	8.7	8.9
1	4	Saibari	46,908		2.5	4.5	6.9		1.8	5.0	9.8		5.8	7.0	7.0
1	5	Mayar	32,610		3.5	9.1	12.3		1.8	7.3	11.6		8.1	10.9	10.6
1	5	Yaring	35,554		4.2	3.6	4.4		2.2	2.9	4.9		6.2	11.7	9.0
1	6	Khokpho	48,157			3.8	9.3			4.0	9.2			9.3	10.1
1	6	Nongchik	31,627			4.7	5.2			5.4	6.9			7.4	7.6
1	7	Muang	40,048		1.8	3.8	6.0		2.8	3.3	4.8		3.9	10.2	12.4
1	7	Yarang	39,703			4.0	5.2			4.1	5.2			8.6	10.2
1	8	Sungaipadee	26,671			3.5	4.2			1.4	1.6			22.9	25.8
1	11	Yee-Ngor	21,902			2.9	7.2			1.8	5.7			15.1	12.7
1	11	Ba-joh	22,952			5.7	3.0			1.9	1.8			27.5	11.9
1	12	Muang	44,696			2.2	19.			1.9	2.0			10.7	9.1
1	12	Takbai	29,468				0.7				0.4				16.9
2	1	Ranode	(74,725)		(1.5)	(7.3)	(4.8)						(10.1)	(11.9)	(9.2)
			71,577		1.5	4.9	5.0		1.2	3.8	5.2		10.0	11.9	9.7
2	1	Sathinpra	(34,232)		(2.1)	(7.5)	(5.6)						(10.6)	(12.3)	(8.5)
			34,334		2.1	7.7	5.9		1.8	5.1	6.3		10.6	12.7	8.9
2	2	Muang	(98,488)		(2.8)	(7.8)	(8.2)						(8.2)	(10.5)	(8.2)
			106,838		36.4	37.7	27.7		17.4	18.9	21.7		16.7	15.8	16.7
2	3	Haadyai	(112,680)			(20.1)	(18.8)							(11.4)	(13.5)
			133,627			20.9	16.2			15.5	14.2			11.6	11.4
2	5	Chanah	(42,918)			(14.3)	(8.9)							(10.9)	(10.8)
			45,027			15.9	7.9			12.8	7.9			11.2	10.1
2	6	Thepta	(24,904)			(10.0)	(10.4)							(14.8)	(7.8)
			24,904			10.7	10.9			6.0	9.0			15.0	12.0
2	10	Muang	(91,580)			(12.7)	(11.1)							(11.5)	(13.0)
			97,629			13.9	10.8			11.3	8.8			11.5	12.6
3	1	Paliam	34,977			0.5	1.2			0.4	1.1			11.3	9.9
3	1	Yantakhoo	33,580			1.2	1.6			0.8	1.3			10.9	10.2
3	2	Muang	97,984			1.7	1.6			0.9	1.3			15.9	13.0
3	2	Kantang	34,331			2.4	2.5			1.9	2.7			11.8	9.0
3	3	Hueyyard	56,161			1.7	0.6			1.8	0.4			12.4	14.6
3	3	Sikow	22,248			0.2	0.5			0.1	0.3			14.7	18.0

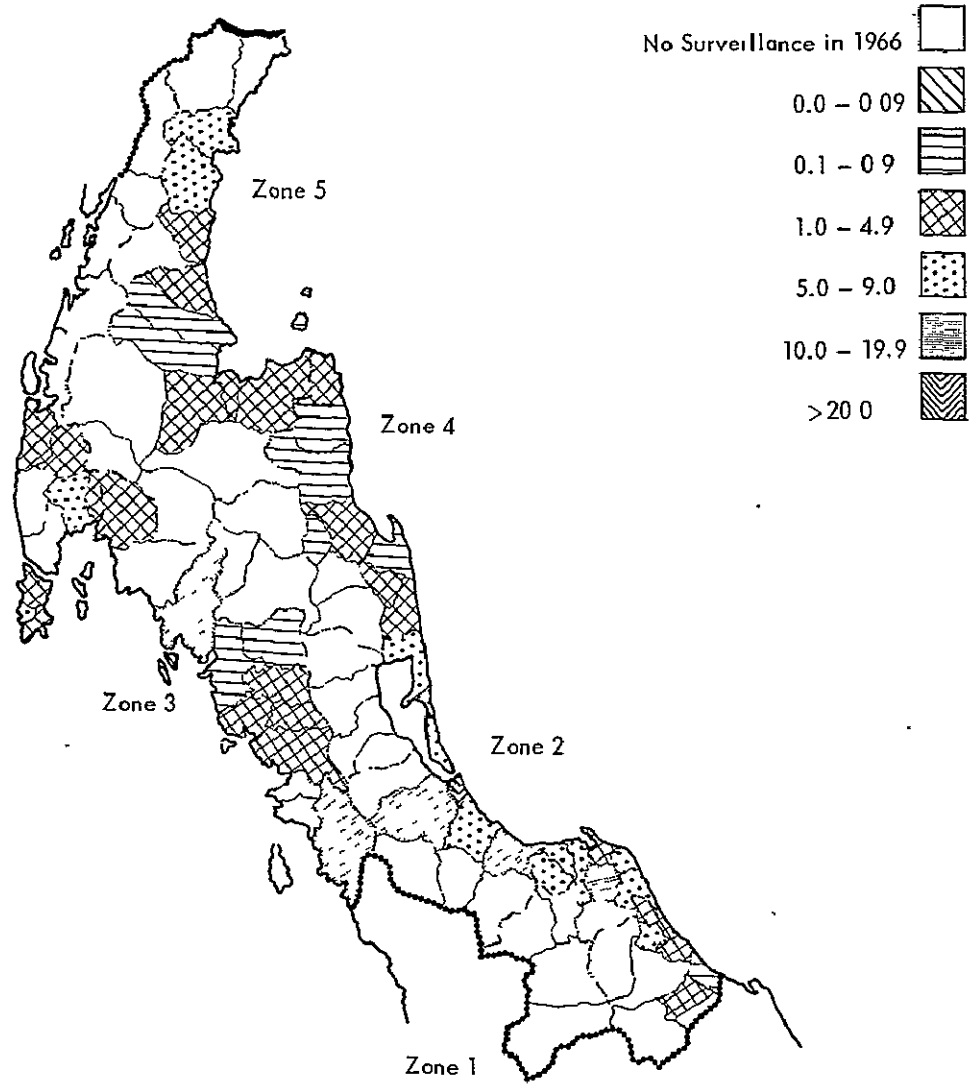
TABLE 1 - Continued

Zone	Sector	District	1966 Pop.	API 1963	API 1964	API 1965	API 1966	SPR 1963	SPR 1964	SPR 1965	SPR 1966	ABER 1963	ABER 1964	ABER 1965	ABER 1966
3	4	Kohlantor	9,346			48.9	21.1			8.6	6.5			42.9	24.2
3	4	Klongthom	27,161				11.5				5.1				23.7
3	5	Muang	59,541				9.8				5.8				17.2
3	5	Aoluk	22,939				3.2				4.4				16.1
3	6	Thupput	11,672				1.9				1.2				13.4
3	7	Takumpor	22,407				3.2				28.7*				12.1
3	7	Kapong	8,544				3.6				2.9				11.8
3	8	Muang	50,090	0.9	2.3	4.3	4.7	2.9	2.2	2.7	4.0	3.0	8.9	13.3	10.9
3	8	Thallung	29,953	0.8	3.2	4.2	4.1	2.6	1.4	1.4	2.1	3.1	13.1	25.3	17.3
3	8	Kathoo	8,819	0.2	2.3	3.7	5.1	1.9	2.2	2.1	3.0	1.3	8.0	13.0	13.7
4	1	Khanom	14,378			2.6	2.9			1.4	1.4			16.7	18.3
4	1	Sichol	40,789			0.3	0.2			0.3	0.2			10.9	12.0
4	2	Thasala	70,169			0.4	0.3			0.3	0.2			14.1	16.9
4	3	Larnsaker	21,344			0.9	0.8			0.4	0.5			18.0	15.2
4	4	Muang	161,426			3.0	1.9			2.6	2.0			10.6	8.9
4	5	Chienyai	59,566			0.8	1.3			0.7	0.8			9.1	14.5
4	5	Pakyang	88,507		1.2	0.9	0.7		0.9	0.6	0.7		12.7	12.9	9.7
4	7	Huasai	54,948		2.5	2.2	1.1		1.4	1.1	1.6		13.9	12.5	9.8
5	1	Kohsanui	33,206	0.9	6.8	6.1	0.48	0.3	2.8	1.9	0.16	2.9	14.4	20.0	26.4
5	2	Kanchanardit	47,703			0.57	1.17			0.35	10.9			14.9	10.7
5	2	Muang	56,759			2.5	2.2			2.4	2.2			9.2	10.8
5	3	Poanpin	43,825			3.5	1.1			1.6	0.7			16.5	16.7
5	5	Chaiya	25,100			0.9	0.4			0.6	0.3			9.8	11.9
5	5	Thachang	17,323			0.9	0.6			0.9	0.45			9.6	12.4
5	5	Thachana	18,825			1.0	1.0			0.8	0.8			10.6	12.0
5	6	Muang	63,942			8.2	9.8			6.5	6.8			10.6	12.7
5	6	Sawee	35,443			1.6	8.7			1.5	6.3			10.4	13.8
5	7	Langsuan	47,042			2.5	2.3			1.9	2.3			8.7	9.7

*These data were calculated by Region 4 headquarters personnel. The data are reproduced here exactly as available and obvious mathematical inconsistencies have intentionally not been corrected.

REGION 4
API BY DISTRICT
1966

FIGURE 1



of perennial transmission without significant seasonal variation. The fact that malariometric surveys were not being conducted when transmission was at its peak meant that the actual incidence of malaria in the groups under study may be obscured.

B. SPRAYING OPERATIONS

A composite presentation by district of the chronology of spray operations during both the control and eradication programs is at Table 2; this includes serial spray data by district for the first spray cycles of 1964–1966. A summary of the first cycle spraying for the whole of Region 4 during the same period is at Table 3. From 1965 to 1966 the percentages of missed and incompletely sprayed houses decreased overall while the grams per capita of DDT applied increased from 102.3 ot 121.0 gms. Despite this evidence of improved spraying cover, in only 13 of the 47 districts with comparable serial data for 1965 and 1966 was there a fall in both the API and the SPR.

TABLE 2
SPRAY OPERATIONS - Region 4

Zone/ Providence	Sector/ District	History of Spray Operations: Control 1st Year	Control Years of Total Coverage	Eradication 1st Year	Eradication Years of Total Coverage	Serial Spray Data: % of Total Houses Missed 1964	1965	1966	% Sprayed Houses Incompletely Sprayed 1964	1965	1966	DDT gms/capita 1964	1965	1966
1, Yala	1, Betong	(1)		1962	1962-66	6.1	24.1	11.4	na	1.4	0.2	76.7	76.9	133.0
	Banningstar	1956	56,57,58,59	1962	1962-66	13.5	16.9	9.5	na	1.7	0.9	87.4	123.4	208.9
	2, Raman	1956	56,57,58,59	1962	1962-66	5.1	7.7	0.1	na	1.5	2.0	75.2	100.3	135.9
	Muang	1956	59	1962	1962-66	3.2	8.3	2.6	na	0.6	7.1	83.5	136.0	117.0
	3, Muang Yaha	1956	56,57,58,59	1962	1962-66	5.8	9.1	0.3	na	0.8	1.1	74.2	114.0	139.1
Pattani	4, Panarch	1953	52,53,54,55	1962	1962-66	9.0	22.8	4.0	na	10.8	9.5	84.1	108.7	265.4
	Saibari	1956	57,58,59	1962	1962-66	4.9	39.7	10.2	na	31.1	13.7	75.9	104.1	169.4
	5, Yaring	(1)		1962	1962-66	0.8	19.8	1.1	na	3.1	0.6	99.7	93.7	133.0
	Mayar	1956	56,57,58,59	1962	1962-66	0.3	N.A.	3.6	na	1.8	0.3	93.8	95.4	137.6
	6, Khokpho	1956	57,58,59	1962	1962-66	4.8	22.1	2.9	na	2.6	1.8	70.2	93.7	164.0
	Nongchik	1956	(2)	1962	1962-66	5.8	12.7	3.3	na	3.5	1.3	58.7	141.3	166.8
	7, Muang	1956	(2)	1962	1962-66	14.0	24.5	4.7	na	26.7	26.6	63.5	85.0	111.0
	Yarang	1956	56,57,58,59	1962	1962-66	5.3	9.7	1.4	na	12.4	15.7	67.2	122.6	152.0
Narathiwas	8, Sungaikolok	1956	56,60	1962	1962-66	2.1	14.0	2.6	na	3.1	1.1	71.3	82.4	137.5
	Sungaipadee	1956	56,57,58,59	1962	1962-66	8.8	11.5	6.4	na	2.7	6.1	70.8	84.6	109.7
	Waeng	1956	(2)	1962	1962-66	3.8	15.3	6.2	na	3.4	2.0	73.0	85.6	154.6
	9, Ra-ngae	1956	58,59	1962	1962-66	6.6	6.5	2.0	na	N.A.	4.8	73.3	91.7	109.1
	10, Rue Soh	1956	56,57,58,59	1962	1962-66	4.8	16.8	3.9	na	5.1	6.5	62.1	103.1	101.3
	11, Yee-Ngor	1956	56,57,58,59	1962	1962-66	10.5	12.5	8.0	na	4.5	16.7	81.4	120.9	126.9
	Ba-joh	1956	56,57,58,59	1962	1962-66	12.8	20.5	6.4	na	12.1	21.4	81.7	101.7	122.3
	12, Muang	1956	(2)	1962	1962-66	8.2	9.1	6.4	na	1.0	5.4	75.6	110.2	113.7
	Takbai	1956	57,58,59	1962	1962-66	4.8	3.7	7.3	na	N.A.	7.1	83.6	101.4	106.9
2,Songkhla	1, Ranode	1956	(2)	1962	1962-66	6.9	2.1	6.8	na	13.5	15.5	83.1	186.8	108.8
	Sathingpra	1956	56,57,58	1962	1962-66	7.7	2.0	4.1	na	8.1	9.6	80.6	100.3	127.6
	2, Muang	1956	(2)	1962	1962-66	13.7	9.8	2.5	na	13.8	22.1	83.6	97.2	104.6
	3, Haadyai	1955	55,56,57	1962	1962-66	12.4	9.5	4.2	na	4.6	9.5	98.3	100.9	132.6
	4, Sadao	1956	56,57,58,59,60	1962	1962-66	6.5	10.5	5.0	na	4.5	4.3	91.1	108.4	150.3
	5, Nathawee	1956	56,57,58,59	1962	1962-66	4.6	3.2	0.9	na	1.4	2.7	70.2	104.8	143.2
	Chanah	1956	56,57,58,59,60	1962	1962-66	3.9	2.2	1.0	na	1.8	1.8	68.5	98.2	113.9
	6, Thepta	1955	55,56,57,58,59	1962	1962-66	6.0	4.5	5.0	na	6.8	3.3	98.8	125.7	143.5
	Sabayai	1955	55,57,58,59	1962	1962-66	7.7	2.6	7.5	na	7.5	6.1	84.3	109.9	204.4

TABLE 2 - Continued

Zone/ Province	Sector/ District	History of Spray Operations: Control 1st Year	Control Years of Total Coverage	Eradication 1st Year	Eradication Years of Total Coverage	Serial Spray Data: % of Total Houses Missed 1964	1965	1966	% Sprayed Houses Incompletely Sprayed 1964	1965	1966	DDT gms/capita 1964	1965	1966
Satoon	7,Muang	1955	55,56,57,58,59	1962	1962-66	3.6	2.4	1.9	na	9.2	11.2	81.8	107.4	133.1
	8,La-ngoo	1955	55	1962	1962-66	0.4	3.3	0.4	na	2.1	3.4	80.5	71.8	94.9
	Thoongwa	1955	55,56,57,58,59 60	1962	1962-66	0.3	0.6	0.1	na n	0.1	0.2	97.2	99.7	113.4
Pattalung	9,Khao Cheison	1953	53,54	1962	1962-66	3.5	0.4	1.2	na	6.3	9.9	79.5	103.7	125.5
	Pakpayoon	1953	53,54	1962	1962-66	1.4	2.3	1.3	na	9.8	9.6	75.8	106.0	126.6
	10,Muang	1952	52,53,54,55,56 57	1962	1962-66	0.6	4.2	1.4	na	10.8	17.1	107.9	105.7	154.5
	11,Kuan Kanoon	1953	53,54,55	1962	1962-66	0.7	3.4	1.1	na	5.0	4.3	89.4	94.2	126.7
	12,Rattapoorn	1954	54,55,56,58,59	1962	1962-66	4.9	1.0	0.6	na	8.2	7.9	94.2	117.7	169.5
3,Trang	1,Yantakhoo	1952	52,53,54	1962	1962-66	0.8	6.3	8.5	na	1.8	1.3	92.2	98.0	147.6
	Paliam	1953	53,54	1962	1962-66	1.4	8.5	4.1	na	3.8	0.07	98.2	96.1	132.7
	2,Muang	1952	52,53,54	1962	1962-66	2.3	6.1	5.1	na	2.8	2.4	89.2	104.7	135.5
	Kantang	1953	53,54	1962	1962-66	1.7	3.9	5.9	na	4.9	1.2	89.5	91.2	122.6
	3,Hueyyard	1953	53,54,58,59	1962	1962-66	0.02	2.6	0.5	na	2.8	2.9	103.3	132.6	161.2
	Sikow	1953	53,54,59	1962	1962-66	0.09	2.7	0.4	na	1.3	1.8	90.9	118.3	124.3
Krabi	4,Klongthom	1953	53,54,58,59,60	1962	1962-66	0.1	4.5	7.1	na	0.4	1.9	74.4	91.4	106.6
	Kohlantor	1953	53,54,55,58,59 60	1962	1962-66	0.0	8.3	7.1	na	3.6	3.2	80.9	131.2	133.6
	Muang													
	5,Muang	1953	53,54,59,60	1962	1962-66	1.1	3.5	3.2	na	0.5	1.0	95.0	95.7	126.5
	Aoluk	1953	53,54,55,59,60	1962	1962-66	1.7	1.4	0.6	na	0.5	1.5	101.3	97.9	123.6
Pang-nga	6,Muang	1955	55,56,59	1962	1962-66	1.6	5.5	1.1	na	4.7	1.8	81.6	77.2	112.8
	Thupput	1955	55,56,57,58,59	1962	1962-66	0.1	3.1	1.8	na	2.8	6.6	85.4	94.2	156.6
	Takuatoong	1955	55,57,58,59	1962	1962-66	0.1	4.1	0.6	na	3.6	0.7	79.4	85.5	114.5
	Kah Yao	1955	55,59,60	1962	1962-66	0.0	0.5	0.09	na	0.0	1.1	84.9	69.5	138.0
	7,Takumpor	1955	55,56,57,58,59	1962	1962-66	0.0	7.1	0.8	na	0.5	3.3	68.2	76.8	109.6
	Taimuang	1955	55,57,59	1962	1962-66	0.09	6.8	3.5	na	0.3	4.0	76.0	77.5	121.0
	Kohkarkhao	1955	55,57,59	1962	1962-66	0.4	3.0	3.2	na	0.5	3.1	66.0	97.4	86.9
	Kapong	1955	55,59	1962	1962-66	0.2	3.1	6.2	na	0.6	1.8	61.3	81.2	55.8
Phuket	8,Muang	1956	56,57,58,59	1962	1962-66	0.01	4.6	1.5	na	0.5	6.2	90.3	91.5	118.5
	Thallung	1956	56,57,58,59	1962	1962-66	0.0	6.7	6.5	na	1.7	2.5	76.1	98.2	122.9
	Kathoo	1956	56,57,58,59	1962	1962-66	0.0	6.5	2.4	na	3.1	12.4	69.4	95.0	138.9

TABLE 2 - Continued

Zone/ Province	Sector/ District	History of Spray Operations: Control 1st Year	Control Years of Total Coverage	Eradication 1st Year	Eradication Years Total Coverage	Serial Spray Data: % of Total Houses Missed 1964	1965	1966	% Sprayed Houses Incompletely Sprayed 1964	1965	1966	DDT gms/capita 1964	1965	1966
4, Nakhanm Sritha-meat	1, Khanom	1956	56,57,58,59	1962	1962-66	6.1	22.7	17.7	na	9.4	2.7	91.8	86.7	102.2
	Sichol	1956	56,57,58,59	1962	1962-66	2.8	11.6	9.4	na	5.1	8.5	122.7	94.3	105.4
	2, Thasala	1956	(2)	1962	1962-66	2.5	10.8	23.0	na	4.4	8.9	77.7	79.9	104.0
	3, Larnsaker	1955	55,56,57,60	1962	1962-66	2.9	8.3	7.0	na	5.4	2.4	41.8	88.9	97.8
	Muang	1956	(2)	1962	1962-66	8.6	33.4	18.0	na	11.5	11.1	80.2	71.3	85.7
	4, Muang Pakyang	(1)		1962	1962-66	1.7	13.2	14.9	na	3.0	2.3	107.5	95.0	80.7
	6, Chienyai	(1)		1962	1962-66	5.4	21.2	23.8	na	7.5	3.2	79.3	84.1	96.6
	7, Huasai	(1)		1962	1962-66	1.8	13.4	16.3	na	10.2	20.8	103.2	110.2	167.7
	8, Cha-vad	1955	55,56,57,58,59 60	1962	1962-66	3.3	16.6	8.9	na	3.5	7.2	94.5	93.3	111.8
	9, Ranpiboon	1954	55,59	1962	1962-66	2.6	6.9	11.4	na	2.2	3.6	81.8	76.8	111.0
	10, Thoung Song	1955	55	1962	1962-66	2.3	6.1	4.0	na	2.8	4.5	95.9	90.5	96.7
	11, Thoongyai	1955	55,60	1962	1962-66	1.9	6.0	5.1	na	1.4	17.2	85.8	80.3	87.2
	12, Chawong Chawong	1956	60	1962	1962-66	5.1	12.4	5.6	na	4.4	8.4	77.7	71.8	84.0
Surath-ani	1, Kohsanui	1956	55,57,58,59	1962	1962-66	6.4	2.6	0.5	na	7.4	7.2	101.9	107.1	91.1
	2, Muang	1956	(2)	1962	1962-66	11.2	14.4	7.4	na	5.2	5.0	79.3	90.7	90.4
	Kanchanardit	1956	(2)	1962	1962-66	8.2	11.1	11.4	na	2.2	0.8	87.2	75.9	83.2
	3, Poanpin	1956	(2)	1962	1962-66	11.5	14.9	20.2	na	14.1	18.8	114.0	89.0	91.0
	Kiriratnikom	1956	(2)	1962	1962-66	7.1	11.0	11.3	na	6.2	4.4	111.5	107.0	101.5
	Panom	1956	(2)	1962	1962-66	5.8	16.5	21.8	na	6.7	0.0	105.8	117.8	96.8
	4, Bannasan	1956	58,59	1962	1962-66	3.7	5.2	6.0	na	2.4	6.6	76.7	166.8	83.7
	Prasaeng	1956	56,57,58,59,60	1962	1962-66	2.2	3.5	3.1	na	4.0	2.1	63.3	88.4	72.0
	5, Chaiya	1956	(2)	1962	1962-66	2.7	19.1	8.5	na	15.6	11.8	83.4	110.5	115.6
	Tkachang	1956	(2)	1962	1962-66	2.5	24.0	15.5	na	16.4	8.8	86.3	86.8	102.6
	Tkachana	1956	57,58,59	1962	1962-66	8.2	19.2	1.2	na	14.3	5.1	69.9	105.2	94.6
Chumporm	6, Muang	1955	1955-60	1962	1962-66	12.2	24.0	17.7	na	23.4	14.5	79.4	138.8	114.3
	Sawee	1955	1955-60	1962	1962-66	8.9	20.3	18.1	na	22.7	7.9	79.4	75.2	163.1
	Langsuan	1955	1955-60	1962	1962-66	4.1	14.1	3.6	na	20.9	18.5	68.5	76.5	74.4

TABLE 2.- Continued

Zone/ Province	Sector District	History of Spray Operations				Serial Spray Data								
		Control		Eradication		% of Total Houses Missed			% Sprayed Houses Incompletely Sprayed			DDT gms/capita		
		1st Year	Years of Total Coverage	1st Year	Years of Total Coverage	1964	1965	1966	1964	1965	1966	1964	1965	1966
	Patoh	(1)		1962	1962-66	0.6	0.7	11.2	na	3.2	5.2	62.4	103.3	109.1
	8,Thasai	1955	55,56,57,58,59 60	1962	1962-66	3.0	11.7	2.1	na	2.3	7.5	102.1	85.6	106.0
	Pathio	1955	55,56,57,58,59 60	1962	1962-66	5.6	11.5	6.2	na	10.0	7.0	82.9	66.7	94.9
Ranong	9,Muang	1955	55,56,57,58,59 60	1962	1962-66	2.8	9.2	9.2	na	19.1	26.8	61.7	79.5	120.9
	Kraburi	1955	55,56,57,58,59 60	1962	1962-66	1.5	7.1	3.9	na	16.6	25.5	85.6	91.6	170.9
	Lu-un	1955	55,56,57,58,59 60	1962	1962-66	0.3	3.0	2.4	na	4.7	20.4	84.0	91.5	144.8
	Ka-pur	1955	55,56,57,58,59 60	1962	1962-66	3.3	2.7	6.6	na	23.1	7.4	85.3	93.9	142.2

TABLE 3
SPRAYING OPERATIONS

	1st Cycle-1964 Region 4	1st Cycle-1965 Region 4	1st Cycle-1966 Region 4
Villages	6,729	5,490	5,197
Houses Sprayed (Total/Incomp.)	603,174	532,609/35,561	631,403/47,991
Missed Houses (Locked/Refused)	32,138	43,722/15,786	23,861/15,736
Percent of Missed Houses	5.0	11.1	6.2
No. of Occupants			
Houses Sprayed	2,986,021	2,854,733	3,119,583
Per House Sprayed	4.9	5.3	4.9
No. Square Meters			
Sprayed	90,796,240	98,505,236	106,138,343
Per House	150.5	184.9	168.0
Per Capita	30.4	34.5	34.0
No. of Kgm. 75% DDT			
Kgm. Used	257,050.5	292,092.0	377,470.0
Gm. per House	426.1	548.4	597.8
Gm. per Capita	86.0	102.3	121.0
Dosage gm/sqm.	2.10	2.17	2.62
No. Sprayman Days	64,312	65,977	78,445
No. House/sqm. per Day	9.3	8.0	8.0
Sqm. Sprayed/sqm. per Day	1,400.9	1,493.0	1,353.0

In each of the 47 districts where two serial years of data indicate a trend in malaria incidence, a comparison of Table 1 with Table 2 permits an attempt at correlating this trend of of the API and SPR with spray operations. The chart that follows, (Table 4), summarizes this comparison and does not present any evidence that an increasing DDT application or a decreasing percentage of missed or incompletely sprayed houses have produced a related decrease in the malaria incidence as measured by the SPR or API.

TABLE 4
SPRAY AND SURVEILLANCE DATA FROM 47 DISTRICTS IN REGION 4

1965-1966 Trend in Malaria Incidence	Total Districts	District % Missed Houses			District % of Houses Incompletely Sprayed			DDT Application gms/capita	
		Increase	Decrease	N.A	Increase	Decrease	N.A.	Increase	Decrease
API and/or SPR increasing	34	9	24	1	10	22	2	28	6
API and SPR decreasing	13	2	11	-	7	6	-	12	1

This suggests that in this Region of Thailand the epidemiology of malaria is such that further improvement in the efficiency of spray operations plus an increasing application of DDT per capita may not by itself produce a further fall in malaria incidence.

It was noted that the Squad Chief's estimates of house sizes, on which the dosages of DDT in grams per square meter were based, varied greatly from day to day even within single villages. Accordingly data based on these estimates were not analyzed. It is evident however that an attempt

to rationalize these estimates within at least single districts would add to the reliability of calculations based upon them, particularly in respect of the totals of DDT used in any one area.

The timing of spray cycles in most of the zones in Region 4 is not based on the transmission season. For example in the two southernmost zones of the Region, logistic difficulties during the monsoon season were cited as the reason why spray cycles could not be performed closer to the peak of transmission in February and March.

Despite these factors, in the houses and villages visited when surveying the surveillance activities, even in the remotest areas, the spray coverage was noticeable and impressive.

C. RELIABILITY OF COMMUNICATION OF DATA AND DATA PRESENTATION

1. Reliability of the Communication of Data

The Region 4 summary of surveillance for 1966 for each of the three zones and seven sectors visited was compared with the zone and sector records which contained comparable data in forms MS3, MS5, MS7, and MS8. The record of the number of ACD, PCD, MBS (mass blood survey) slides were compared, as were the number of positive cases from each source, the species diagnosis, the total number of cases, the cases investigated, and the case classifications. The results of this number by number comparison which are summarized in Table 5 show a wide discrepancy in region, zone and sector data that should have been identical.

The MS8 (malaria case registration book) which should contain a record of all ACD and PCD cases disagreed 10 out of 10 times with the total of ACD and PCD cases reported in the MS3 and MS5 forms for the same zone or sector. Both the number of ACD cases and PCD cases were inconsistent. The PCD discrepancy was the most marked, and the MS8 always contained fewer PCD cases than were reported on the MS5. The ACD error was less, and the MS8 might contain more or fewer cases than the MS3 in any individual instance checked.

The regional summary of surveillance totals for ACD and PCD slides and positives varied widely from the MS3 and MS5 totals in both zone and sector offices. In one zone (Zone 4) the same summary of surveillance had been completed by the region and the zone. If different the

TABLE 5
RELIABILITY OF THE COMMUNICATION OF DATA

	Figures Checked	Number Inconsistent	Percent Inconsistent
Region 4 to Zone 2 (Songkhla)	124	52	41.9
Zone 3 (Trang)	120	40	33.3
(example presented) -			
Zone 4 (Nakharn)	117	71	60.7
Region 4 to Zone 2 Sector 3 (Haadyai)	82	21	25.6
Zone 2 Sector 5 (Chanah)	68	18	26.5
Region 4 to Zone 3 Sector 2 (Muang)	74	34	45.9
3 Sector 3 (Hueyyad)	79	41	51.9
3 Sector 8 (Phuket)	67	37	55.2
Region 4 to Zone 4 Sector 2 (Thasala)	67	12	17.9
4 Sector 4 (Muang)	72	18	25.0
Zone 2 to Sector 3	54	27	50.0
Zone 2 to Sector 5	27	24	51.1
Zone 3 to Sector 2	78	29	37.2
Zone 3 to Sector 3	81	34	42.0
Zone 3 to Sector 8	72	19	26.4
Zone 4 to Sector 2	68	27	39.7
Zone 4 to Sector 4	64	32	50.0
TOTAL	1,334	536	40.2

TABLE 6
A COMPARISON OF REGIONAL AND ZONE SUMMARIES
OF SURVEILLANCE FOR ZONE 4 REGION 4
(Zone data in parenthesis if
different from Region)

Months	Population	ACD Exam/Pos.	PCD Exam/Pos.	MBS Exam/Pos.	Total Cases	Cases Invest.
January	492,506(480,306)	4388(4387)/29(30)	386(194/28(20)	0(4)/0	57(44)	26(39)
February	489,575	5134(5131)/67	299/40	0/0	107(61)	56(61)
March	495,893(495,967)	4405/63	304/40	0/0	103(84)	65(83)
April	498,223(429,642)	4149(4148)/47(55)	218/32	38(83)/0	79(85)	58(80)
May	498,147(485,842)	4437(4458)/25	357/25	355(270)/2	52(48)	40(48)
June	475,407(487,867)	5157(5161)/23(24)	337(407)/19	863(735)/0	42(40)	34(40)
July	487,202(488,922)	5387(5388)/28(27)	266/32	602/0	60(28)	24(26)
August	487,066(352,204)	5441(5449)/12	466(424)/1	343(308)/0(3)	13(17)	15(16)
September	481,506(486,700)	5799/10	474(421)/33(29)	321(333)/0	43(16)	11(16)
October	480,711(461,738)	5521(5522)/7	235/4	182(158)/0	11(13)	11(13)
November	476,260(485,210)	2071/3	242/9	93(118)/0	12(8)	7(8)
December	481,579(486,856)	3690/6	350/26	140/0	32(15)	10(15)
TOTALS	522,368(495,967)	55,580(55,609)/320(329)	4034(3817)/289(277)	2937(1751)/2(5)	611/(459)	359(445)

zone totals are shown in parentheses, and indicate that out of 117 figures compared, 71 or 60.7% were inconsistent (Table 6). Since the regional summary of surveillance is used to calculate annual malaria incidence (API and SPR), it is easy to see how the differences, previously noted, can arise and prejudice assessments of progress.

In Table 5, a summary of this validity check is made. It shows an overall error of 40.2% in the transmission of data. Since the MS3 and MS5 forms are filled out in the sector by the sector chief in quadruplicate without carbon, this is one possible source of error; another possible source is introduced when region or zone clerks transcribe these figures onto summaries of surveillance.

2. Data Presentation

The graphic and tabular presentation of data was also examined in each of the three zone and seven sector offices visited. There was little uniformity in these offices in the manner in which data are presented. In only one zone office were API's, SPR's, and ABER's being followed district by district. Malariometric survey results were also presented in an unstandardized manner that made comparison of techniques and results nearly impossible. One chart, commonly found, plotted the number of slides collected and the number of positive cases by month. In at least one office, however, the results presented by this chart were completely misinterpreted by the person who had plotted the points. There, the assumption was being made that malaria incidence was decreasing because the chart showed that both the number of slides collected and the number of of cases were decreasing. In fact, the former was decreasing at a greater rate than the latter, so that the SPR was actually increasing.

Maps plotting malaria cases by location occasionally contained more than one year's total of cases. District maps seldom were designed to show individual house visitor's areas of responsibility.

It is believed that the Region 4 data presentation could be improved in several ways: (a) by standardizing a few meaningful charts that could be used in all zone and sector offices; (b) by instructing zone and sector personnel in the correct use and interpretation of the charts and graphs employed; (c) supervision by regional inspectors could include a check on the quantity and accuracy of data presented.

D. SURVEILLANCE NETWORK

1. Reliability and Coverage

The work of the house visitor was evaluated in several ways. By utilizing the fixed itinerary of house visitors on form MS1b and the records of ACD slides collected by village during each day of this itinerary, form MS1a, it was possible to reconstruct the daily blood smear collections by village for any house visitor. Positive cases were also listed on this form with the data supplied from the MS2 or L5a forms. This analysis was done for 13 house visitors in Region 4 and two

examples are included (Tables 7 and 8). Table 7 illustrates the work of a house visitor in Zone 3, Sector 8 (Phuket) who visited houses in a municipal area which was not being sprayed. The poor coverage may be contrasted with Table 8 which is one itinerary covered by two successive house visitors. The coverage of this itinerary improved remarkably in April 1966, when the first house visitor was replaced. The reason given for poor coverage in Phuket was that city dwellers would not cooperate with any house visitor, but as demonstrated, this does not seem to be consistent with the experience in the other large population center in Zone 4. Table 9 summarizes the results of these analyses which were done for 13 house visitor itineraries. For each itinerary, the number of days was calculated on which ACD slides were collected for at least nine months of 1966 and then this was expressed as a proportion of the total days of the itinerary. In addition, for each of the 13, the number of monthly cycles was determined for which ACD slides were collected during at least three-quarters of the days of the itinerary. This number was expressed as the percent of the total visiting cycles for 1966.

Certain other findings involving the coverage by the house visitor became apparent while these analyses were being made.

Many visitors had apparently been instructed to supplement low slide collections by visiting schools. However, instead of making collections on a history of current or recent fever at the schools, they conducted a mass blood survey which might include all of the children in a single class. Each of the slides collected in this manner was then listed on the MS2 form as "fever" or "history of fever." Slides collected in this manner should only be classed as mass blood survey slides and should not be included in the ACD totals. In fact, all slides collected by house visitors were being listed as ACD slides. This included slides collected either because individuals had been previously positive or had slept away from their homes or were visitors to the house. It is important that the ACD total should be reserved for individuals with fever or a history of fever and that collections other than this should be placed in a survey or investigation category. In the analyses presented, (Tables 7-9), slides from these erroneous sources have been deducted from the ACD totals.

The job turnover among house visitors is very heavy. Several itineraries were covered during 1966 by a succession of three or even four house visitors and in only two of 13 itineraries analyzed was the same individual on the job for the whole year. Often reserve visitors were not available and there were consequently gaps of up to six weeks without coverage for this reason.

The practice of assigning a "quota" of slides to be obtained each month for each visitor, usually 1% of the population covered, has several disadvantages. If a worker reached his total early in the month, there was a tendency to overlook the remainder of the villages, the quota often being regarded as a maximum rather than a minimum. Finally, a monthly quota does not encourage the essential uniformity of coverage during every day of the cycle.

By listing both ACD slides and positive cases of malaria, it was quickly possible to identify infected villages within single itineraries, or cantons or districts that had an unusually high incidence of malaria. Early detection of foci in villages is important if it leads to prompt remedial action.

It was frequently noted that house visitors were not completing the MS1a form properly. For example, if the target number of houses was 65 in May and the visitor visited 68 houses, his target for June would still be listed as 65.

The work of seven house visitors was also evaluated through the checking of house cards by actually visiting villages to confirm the dates of house visits and of blood slide collections and if presumptive treatment was given. The results of this evaluation are summarized in Table 10.

A house was considered inadequately visited if the house card was absent or not signed by the house visitor for two of the three previous months. The MS1a forms examined always reported that presumptive treatment had been administered, though this could be confirmed for only 75.8% of the fever cases.

TABLE 7

COUNTRY, THAILAND, ZONE 3, SUB ZONE IDENTIFICATION Sector 8 (Phuket - Muang District) H.V. 6

ACD BLOOD SMEAR COLLECTION BY LOCALITY

Day	Canton	Village	Pop.	House No.	JAN		FEB		MAR		APR		MAY		JUNE		JULY		AUG		SEPT		OCT		NOV		DEC		Total smears	Smear per 100 pop.
					I	S	I	S	I	S	I	S	I	S	I	S	I	S	I	S	I	S	I	S	I	S	I	S		
3	Phuket	Muang municip.	375	71									1								3						1		5	1.3
4			348	65			1								5								1						7	2.0
5			303	52			1								5								1		2				9	3.0
6			356	62			1								7		1				1		1						11	3.1
7			339	63											6				11				2		9				28	8.2
8			299	58																										0.0
9			332	69	2																								2	0.6
10			312	78							1																		1	0.3
11			274	58	3																								3	1.3
12			316	59															7						1				8	2.5
13			342	52																										0.0
14			448	71	1						1				1										1				4	0.9
15			349	69											1				3										4	1.1
16			298	70																			12						12	4.0
17			246	58											1		1												2	0.8
18			661	95							1				1														2	0.3
19			366	63																					1				1	0.3
20			383	71	2		1										2												5	1.3
21			525	71									2				1				2						3		8	1.5
22			755	104																										0.0
23			724	107																										0.0
24			619	106									3								1								4	0.6
25			497	64	1												1												2	0.4
26			335	54			1																						1	0.3
27			290	53			2		1								2												5	1.7
			10,112	1743	9		7		1		3		6		27		8		21		7		17		14		4		124	1.2

I - ACD Slides

S - Positive Cases

TABLE 8

COUNTRY, THAILAND, ZONE 4, SUB ZONE IDENTIFICATION Sector 4 (Muang District) Covered by 2 visitors-

(Jan.-March (a)
(March-Dec. (b)

ACD BLOOD SMEAR COLLECTION BY LOCALITY

Day	Canton	Village	Pop.	House No.	JAN		FEB		MAR		APR		MAY		JUNE		JULY		AUG		SEPT		OCT		NOV		DEC		Total smears	Smear per 100 pop.
					I	S	I	S	I	S	I	S	I	S	I	S	I	S	I	S	I	S	I	S	I	S	I	S		
3	Salamichai	4	280	60							14		8		4		3		3				4		5		2		43	15.4
4		4	282	69							6		2		7		7		9		4		2		10		2		49	17.4
5		4	111	21							1		10		3		1		1		2								18	16.2
6		3	459	105							5		4		9		4		3		14		4		12				55	12.0
7		3	390	93			4				1		2		4		2		5		4		1						23	5.9
8		3	264	52							5		6		2		7		4		9		7		9		8		57	21.6
9		2	450	100			3				3		2		1		4		1		5		2		2				23	5.1
10		2	451	99							10		1		2		1		4		5		3		4		4		34	7.5
11		1	319	74							4		2		4		4		1		3		5		5				33	10.3
12		1	310	63							1		1		11		4		7		7		3		7		10		51	16.5
13		1	180	46			1						6		5		10		3		6				9		8		48	26.7
14	Natharra	3	271	55	3				2				5		5		2				5				(66)				22	8.1
15		3	266	71	3		1				1		1		5		3		4		3		3						24	9.0
16		2	224	83			2		1				4		2		1				10		1						21	9.4
17		2	312	82			2				4		5		2		1		8		3		13				6		44	14.1
18		2	212	82	5				1		4		(21)				5		8	1	7						3		34	16.0
19		2	241	82			4		1		9		3		7		3		7		3		2				4		43	17.8
20		1	266	59					2		1		1		1		2		31				5				1		15	5.6
21		1	302	61					8		5		2				4		3		3		2				7		34	11.3
22		11	273	85	1		5		1		2		5		2		5		3		2		8				(66)		34	12.5
23		10	561	105					5		1		2		7		8		4		4		8				12		51	9.1
24		10	432	84							2		9		10		3		9		5		4		1		1		44	10.2
25		10	340	65					5		2		1		5		3		7		9		9				9		43	12.6
26		10	388	74							10		10		10		8		5				5				4		52	13.4
					H.V. (a)						H.V. (b)																			
			7584	1770	12		22		26		91		92		108		95		100	1	113		91		64		81		895	11.8

Circled are collections from schools where surveys were done.
These are deducted from daily coverage.

I - ACD slides
S - Positive cases

TABLE 9
DAILY ANALYSIS OF HOUSE VISITORS SLIDE COLLECTION

Zone	Sector	House visitor's itinerary No.	No. of days on itinerary	No. days w/ACD slides for at least 9 months of 1966	Percent of days in itinerary w/ACD slides for 9 months of 1966	Percent of house visiting cycles for which ACD slides were collected during 3/4 of days in itinerary
3	2	1	25	14	56.0	58.3
		2	25	5	20.0	8.3
	3	1	24	20	83.3	83.3
		2	25	10	40.0	16.7
	8	6	25	0	0.0	0.0
		5	25	1	4.0	8.3
4	4	8	24	13	54.2	58.3
		7	24	13	54.2	66.7
	2	4	25	15	60.0	41.6
		8	24	16	66.7	50.0
2	3	3	25	23	92.0	83.3
	5	3	26	4	15.4	9.1
		5	24	19	79.2	81.8

TABLE 10
SUMMARY OF HOUSE VISITOR ANALYSES

Zone	Sector	Houses checked	No. inadequate visited	Percent inadequate visited	Fever cases checked	No. verified	Percent verified	No. receiving presumptive cure
3	2	25	2	8.0	9	9	100.0	7
	3	15	1	6.7	5	5	100.0	4
	8	10	2	20.0	2	2	100.0	2
4	2	8	0	0.0	1	1	100.0	1
	4	20	1	5.0	6	6	100.0	5
2	3	15	3	20.0	5	4	80.0	3
	5	18	4	22.2	5	5	100.0	3
Totals		111	13	11.7	33	32	97.0	25(75.8%)

2. Evidence of bias

In addition to evaluating the house visitor's activity by the actual checking of houses and villages visited, evidence of bias was also sought in the visitor's work by examining records available for sex and age distribution of ACD slides.

As the introduction of surveillance in an area implies a low level of malaria endemicity, the distribution of positive blood slides within the population under ACD is of great epidemiological importance. A wide disparity between the number of slides collected from the various age groups suggest the possibility of bias in sampling which will make difficult an accurate assessment of the malaria incidence as measured by the age distribution of positive blood slides.

For example, a house visitor may not be contacting working age males or school age children when visiting houses during the day. In omitting this group the resulting incidence rates may be falsely low when in fact the incidence of fever due to malaria may be concentrated but not detected in either working age males or school children. Where, however, the ACD blood slides are collected proportionately from all age groups in the communities visited and there is disparity in the incidence of positive slides between the various age groups, an unusual epidemiologic situation is indicated which warrants more extensive investigation.

Table 11 presents the age and sex distribution for four districts in Region 4. In Zone 2, Sector 3 (Haadyai district), 67.3% of the positive cases are among males, a male:femal ratio of 2:1. This distribution, however, closely parallels the sex distribution in ACD slide collections in the same district (65.1%M). This would indicate a bias in slide taking. In contrast, in Zone 3, Sector 8 (Phuket Muang district), the ACD slide collection age and sex distribution is not dissimilar from that of the population-at-large indicating an unbiased slide collection. But here there is a male:female ratio of positive cases of 9:1. In the absence of bias in slide taking, this strongly suggests that males in this district are at much greater risk of contracting malaria. Looking at the age distribution of cases among males in this same district, we find that 70.1% of all cases of malaria are in males 15-39, though only 23.5% of the slides and 19.3% of the population are in this age group. This information can be used as a guide to understanding the epidemiology of malaria in this district and will be commented on in more detail in another section.

3. Time Intervals Between Slide Examinations and Action

The prompt treatment of confirmed cases of malaria plays a critical role in the interruption of transmission. Time intervals related to positive slides were accordingly examined in two ways: (a) from the date of collection to the date the result was transmitted to the sector office; and (b) the time interval between the report to the sector and the start of radical treatment. Only those positive cases actually receiving radical treatment were analyzed. The total time interval from slide collections to the start of radical therapy, which is the sum of these two was determined. Time intervals for negative slides from the date of collection to the date of laboratory examination were also calculated. Table 12 presents the negative slide data and Table 13 contains the positive slide data.

There is wide variation in the length of time taken between slide taking and case investigation and the start of radical cure. Where this total time lag is over three weeks as in Sectors 3 and 5 of Zone 2, most of the delay is at the Sector Offices. This appears to be due to the unusually heavy case loads at these Offices as the number of individuals assigned to investigate cases at sector offices ranges from only 2 to 4. Despite the fact that in 1966 there was as few as 25 cases in Thasala or as many as 2161 cases in Haadyai to be investigated and no redeployment of personnel appears to have been considered.

The data in Table 13 demonstrates that slide examination results are being sent from zone laboratories to sector offices without unreasonable delay.

4. Epidemiological Investigation, Radical Treatment and Case Follow-up

After a sector chief has been informed of a positive slide, it is his responsibility to carry out a primary epidemiological investigation within four days of this notification, and to classify the case as to its origin. He is also responsible for giving medical treatment to the individual concerned and for the follow-up thereafter. Pertinent data analyzed for these phases of surveillance are in Table 14

The most striking finding in Table 14 is the very low percentage of cases investigated in five of the seven sectors studied. In Haadyai, for example, which is Sector 3 of Zone 2, despite parasite rates above 2%, the area has been placed under active surveillance because it was deemed advisable "to supplement DDT with drug treatment for positive cases." If this is the purpose, it would then seem advisable to treat more than 59.0% of malaria cases discovered by ACD and to provide the necessary personnel to do so. However, even in sectors with relatively low case loads which assigned personnel could be expected to manage, there is a disturbingly low and unacceptable level of investigated cases persisting.

TABLE 11

AGE AND SEX DISTRIBUTION OF ACD SLIDE COLLECTION AND POSITIVE CASES, 1966

Zone, Sector (District)			2,3 (Haadyai)		3,3 (Hueyyard)		3,8 (Phuket Muang)		4,4 (Nakhorn Muang)	
Age in Years	Sex	Percent Population of Thailand (1960 Census)	Percent Slides	Percent Cases	Percent Slides	Percent Cases	Percent Slides	Percent Cases	Percent Slides	Percent Cases
—1	F	1.2	0.3	0.2	0.0	0.0	0.6	0.0	0.9	0.0
	M	1.2	0.7	0.2	0.0	0.0	0.6	0.0	0.0	0.0
1-4	F	6.8	2.3	2.4	2.6	4.2	7 5	0.0	6.9	0.7
	M	7.0	4.0	5.8	7.0	12.5	8.6	3.9	4.3	2.2
5-9	F	7.5	7.0	6.4	8.8	6.3	4.6	0.8	11.2	5.2
	M	7.7	9.0	8.7	9.6	4.2	9.2	0.8	6.9	5.2
10-14	F	5.8	4.0	3.6	1.8	4.2	2.9	2.4	1.7	4.4
	M	6.0	6.3	6.7	3.5	2.1	4.0	6.3	3.4	3.0
15-19	F	4.7	4.0	7.8	7.0	2.1	14.4	0.8	4.3	3.7
	M	4.8	13.3	14.7	2.6	12.5	7.5	20.5	6.0	20.7
20-29	F	8.6	3.0	4.0	5.3	2.1	8.6	1.6	8.6	3.0
	M	8.5	11.0	17.3	8.8	14.6	10.3	36.2	8.6	26.7
30-39	F	5.9	4.3	3.1	6.1	2.1	6.3	1.6	6.0	3.0
	M	6.0	8.6	7.3	10.5	16.7	5.7	13.4	6.0	10.4
40	F	9.4	10.0	5.1	11.4	6.3	6.9	2.4	12.9	5.2
	M	9.0	12.3	6.7	14.9	10.4	2.3	9.4	12.1	6.7
All Ages	F	49.9	34.9	32.7	43.0	27.1	51.8	9.6	52.6	25.2
	M	50.2	65.1	67.3	57.0	72.9	48.2	90.5	47.4	74.8
Total Numbers		26,257,916	301	450	114	48	174	127	116	135

TABLE 12
NEGATIVE SLIDES - TIME FROM COLLECTION TO EXAMINATION

Zone/Sector/ District	No. Cases Analyzed	Average Time Lag (Days)
3-2-Trang	37	8.9
3-8-Phuket	94	3.7
4-2-Thasala	42	3.4
2-3-Haadyai	25	9.8

TABLE 13
TIME LAGS FOR POSITIVE CASES

Zone/Sector/ District	Average Time Lags (Days)			
	No. Cases Analyzed	Slide Collection to Result Reported	Result Reported to Radical Treatment	Total Time Lag
3-2-Trang	21	10.2	11.5	21.7
3-2-Hueyyod	38	NA	NA	18.2
3-8-Phuket	25	3.9	6.9	10.8
4-4-Nakhorn	14	5.9	7.0	12.9
4-2-Thasala	24	NA	NA	9.0
2-3-Haadyai	31	9.9	62.7	72.6
2-5-Chanah	25	23.2	44.1	67.3

NA - Not Analyzed.

TABLE 14
EPIDEMIOLOGIC INVESTIGATION, TREATMENT, AND CASE FOLLOW-UP (Region 4 Data)

Zone/Sector/ District	Total 1966 cases	Cases investigated	Percent investigated	Cases receiving radical cure	Percent receiving radical cure	Percent radical cases w/ up-to-date follow-up	Average no. invest. slides	Percent indigenous cases
3/2/Muang	246	150	61 0	148	60.2	22.0	Not taken	51.3
3/3/Hueyyod	43	43	100.0	41	95.3	48.4	Not taken	34 9
3/8/Phuket	236	119	50.4	119	50.4	33 7	3.4	16.8
4/4/Muang	308	103	33.4	103	33.4	53.6	Not taken	5.8
4/2/Thasala	25	20	80.0	20	80.0	75 0	15.0	20.0
2/3/Haadyai	2,161	1,275	59.0	1,266	58 6	4.7	Not taken	43.4
2/5/Chanah	359	359	100 0	355	98.9	17.6	Not taken	66.3

Radical treatment had been given to most of the patients found at the time of the investigation, but few of these had been followed up adequately at the prescribed intervals thereafter, to determine the adequacy of treatment. This case follow-up is particularly important in respect to the evaluation of problems such as drug resistance through an analysis of the reinfection or relapse rates.

As an example, cases that are found to be again positive on follow-up are not being counted as "new" cases despite the fact that the time interval may be as long as nine months after initial infection or may be due to an infection with another plasmodium species. Even if these cases must be counted as "relapses" this should be only with a full understanding that a proportion of them may be due to treatment failures through incomplete therapy or drug resistance. Further, these cases are again fully infective to the vector and represent a risk of the spread of malaria. Although the API and SPR for any region would go up if all such cases were classified as new infections rather than the continuation of previous ones, at least the status of malaria would be reflected more accurately. This accuracy is essential in any eradication program.

Also of importance in this Region is the classification of cases by the sector chief as "indigenous" or "imported". Based on information elicited from the patients by the sector chiefs or their assistants and recorded in the MS6 form, all data analyzed from the sectors studied showed a large preponderance of "imported" cases. This unlikely epidemiological situation is the result of a system of case classification now employed which subdivided imported cases into "X", "Y" and "Z" categories. The two former are based on village or canton and district delineations. If a patient had left his village or canton within 6 weeks of the time the positive film was taken, the case is classified as "imported X"; if he had left his district during the same interval, he is classified as "imported Y". In Phuket for example, which is Sector 8 of Zone 3, and is a small island province, only 20 of 119 cases in one district are recorded as "indigenous." Yet only 14 of the remaining 99 persons had been out of this small island community, which is administratively demarcated into villages and cantons, within six weeks of the time the positive slide was taken. It is unrealistic to believe other than that the great majority of cases in Phuket are epidemiologically "indigenous."

This current system of classification also leads to cases being considered "imported" when an individual temporarily leaves his home in the most malarious area of a province to visit in the least malarious area within six weeks prior to the time the positive slide is taken.

Another facet of practical importance is that cases classified as "imported" are not followed up as thoroughly as indigenous cases. In every sector visited the cases classified as "imported" were said to be reported to the sector of origin for follow-up. In none of the sectors visited, however, was anyone able to produce the forms on which these case reports were sent and none of the sector offices could produce a report on cases that were said to have originated elsewhere.

Finally, all sectors visited were in the attack phase and this was given as a reason why blood surveys were not being generally conducted around the homes of positive cases, as advised in the Plan of Operations. The only sectors where this had been attempted were Sector 8 in Zone 3 - Phuket - and Sector 2 in Zone 4 - Thasala. As shown, the average number of slides collected in each instance was insufficient for the purpose.

E. LABORATORY SERVICES

1. Zone and Regional Laboratories

The Regional Laboratory in Songkhla and four of the laboratories where blood slides are examined for the Zone were visited. The number of slides examined daily by each microscopist was noted. In addition, in each laboratory, a detailed examination of random sample of 20 slides was made to determine whether or not each was adequate for the diagnosis of malaria. This analysis included an evaluation of smear thickness; less than 5 WBC per oil field, corrected to an ocular of 7.5X, in the thickest area of the film was considered unacceptable, In addition, debris, dehemoglobinization and staining were evaluated. These three qualities were graded, (a) good: for slides in which debris was minimal and staining and dehemoglobinization were excellent, (b) acceptable: for quality which, though not optimal, was sufficient to allow an effective reading of the slide; and (c) unacceptable: for slides in which any one of these qualities was such as to render the slide unreadable. The results are summarized in Table 15 and show that six of 100 slides examined (6%) were unacceptable.

TABLE 15
SUMMARY: LABORATORY ANALYSIS - Region 4

Zone	No. slides examined/ microscopist/ day	No. slides checked	No. unacceptable because of:				Total unacceptable	
			Inadequate thickness	Debris	Inadequate dehem	Inadequate stain	No	Percent
Regional lab Songkhla	40	20	1	0	0	1	1	5
Zone 2 Songkhla	54	20	1	0	0	0	1	5
Zone 3 Trang	46	20	1	1	0	0	2	10
Zone 3 Phuket	42	20	0	0	0	0	0	0
Zone 4 Nakhorusrithammarat	34	20	2	0	0	0	2	10
TOTALS		100	5	1	0	1	6	6

Although procedures and forms exist for Zone laboratories to inform sector offices of house visitors who consistently prepare poor slides, they are seldom, if ever, used. Consequently, house visitors who prepare poor slides have little opportunity to improve.

There was wide variation in the microscopes used in the Zone laboratory many of which were over twenty years old. Five of forty examined (12.5%) were defective enough to make accurate malaria diagnosis very difficult.

2. Regional Laboratory Cross-checking

The Regional Laboratory at Songkhla cross-checks 9% of the negative slides and 75% of of the positive slides examined by the Zone laboratories; in addition, 1% of the Zone negatives and 25% of the Zone positives are cross-checked at the National Headquarters Laboratory. The results of this cross-checking, during 1966, were examined.

TABLE 16
1966 TOTAL ERRORS
(False positives, false negatives, incorrect species diagnosis)
DISCOVERED BY CROSS-CHECKING AT REGION 4 LABORATORY

	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPT	OCT	NOV	DEC	TOTALS
Zone 1	10	15	7	1	11	1	7	5	4	4	4	6	75
Zone 2	25	31	22	13	12	29	22	15	2	16	6	-	193
Zone 3	21	11	14	8	3	10	5	7	9	23	9	21	141
Zone 4	3	6	5	-	1	-	1	-	1	2	-	-	19
Zone 5	7	17	3	-	5	1	2	5	7	2	9	6	64

It was noted that, during 1966, total errors were consolidated to include false positives, false negatives and incorrect species diagnosis. This practice tends to obscure the most critical error which is the false negative. In January 1967, however, the Regional Laboratory had begun to correct this by tabulating Zone errors according to these categories.

Total errors discovered at the Regional Laboratory for each of the five Zone laboratories are presented by month in Table 16. The one laboratory in Zone 2, made more errors in 9 of

TABLE 17

COMPARISON OF MICROSCOPIST'S EFFICIENCY - Zone 2 and 4

LAB	Micro. No.	Blood Film Exam.	Negative Slides No. Check	Negative Slides Found Pos.	Positive Slides No. Check	Positive Slides Found Neg.	Positive Slides Incor. Species
		MAY, 1966					
Zone 2	1	543	33	-	48	-	-
	2	866	66	2	63	-	-
	3	838	40	1	46	-	2
	4	836	64	2	43	-	-
	5	935	25	1	44	-	-
	6	1,414	106	2	118	1	1
	Total	5,432	344	8	362	1	3
Zone 4	1	200	20	-	-	-	-
	2	1,151	115	1	9	-	-
	3	1,110	111	-	8	-	-
	4	771	72	-	13	-	-
	5	771	75	-	6	-	-
	6	1,064	74	-	2	-	-
	7	766	101	-	11	-	-
	Total	5,833	568	1	49	-	-
		JUNE, 1966					
Zone 2	1	405	27	-	56	-	1
	2	1,113	95	1	99	-	3
	3	1,295	83	2	74	2	4
	4	1,102	91	6	83	-	2
	5	1,278	86	1	109	-	1
	6	1,423	104	3	91	-	3
	Total	6,616	486	13	512	2	14
Zone 4	1	308	30	-	1	-	-
	2	1,263	125	-	4	-	-
	3	1,337	131	-	8	-	-
	4	1,243	123	-	17	-	-
	5	1,074	105	-	7	-	-
	6	1,181	100	-	5	-	-
	7	985	99	-	3	-	-
	Total	7,391	713	-	45	-	-
		JULY, 1966					
Zone 2	1	354	23	-	50	-	1
	2	1,128	108	-	72	3	2
	3	867	65	2	61	-	3
	4	1,179	99	3	91	-	5
	5	1,138	83	-	78	-	-
	6	1,256	99	3	98	-	-
	Total	5,922	477	8	450	3	11
Zone 4	1	471	46	-	1	-	0
	2	1,071	104	-	12	-	-
	3	1,070	107	-	6	-	-
	4	974	96	-	7	-	-
	5	905	90	1	5	-	-
	6	1,020	70	-	1	-	-
	7	702	102	-	1	-	-
	Total	6,213	615	1	33	-	-

the 12 months of the year than any of the others. The Zone 4 laboratory consistently, in 11 of the 12 months, made fewer errors than any of the other laboratories. A breakdown of errors by type in these two laboratories was examined from May to July 1966 to determine (a) whether total errors accurately reflect the number of false negatives, and (b) to determine how frequently false negatives were being read. Table 17 presents this comparison. During this three month period, 1307 negative slides from Zone 2 were cross-checked and 29 or 2.2% were found positive; over the same period of time, 2 0f 1896 negative slides from Zone 4 (0.11%) were positive. It should be noted that a false negative rate of only 0.1% for a total year means that the number of missed cases of malaria exceeds the level acceptable for consolidation.

The consistently poor record of nearly all Zone 2 microscopists could be expected to indicate an effort to re-train them at the Regional Laboratory, particularly as it is in the same township. Unfortunately this had not been done.

F. SUPERVISION

In undertaking this review the team felt that it was important to consider the area of line supervision of surveillance activities. Accordingly, squad and sector chief "advance supervision schedules" were confirmed by examination of the MS1a and the visitors notebook, as well as by checking house cards for their signature in appropriate villages. Eight out of eight visitors' notebooks and MS1a forms confirmed that the visitors had been supervised on the days scheduled, and 12 of 15 house cards were signed by squad and sector chiefs on the correct day. Comments in the visitor's notebook appeared pertinent and comprehensive. This system of squad and sector chief supervision scheduled in advance appeared to be working effectively.

No fixed advance schedules of supervision from Zone or Regional office were maintained. However, many of the areas of work in need of improvement would undoubtedly be improved with consistent supervision from these levels. For example, the data transmitted from sector to zone to region could be checked by personnel from Regional headquarters in a consistent and regular way that would inevitably result in the transmission of more accurate data. Many other opportunities to benefit from line supervision at the zone and region level have already been touched on in this report.

Although Regional supervision of microscopy, administration, and spraying were not checked in detail, it seems probable that with scheduled supervision from this level, both line supervising and training functions might be improved.

G. SPECIAL EPIDEMIOLOGIC OBSERVATIONS

One of the team's purposes within the scope of this review is to attempt to indicate areas where the response of malaria to attack measures has been unusual. In Region 4, one of these areas is Phuket which is Sector 8 of Zone 3. This small island province of 801 sq. km. with a population in 1960 of 75,652 has been the focus of an intensified effort in the past to quickly achieve malaria eradication. House spraying with DDT has been practiced since 1956, and since 1962 when the eradication program began, this spray cover has been complete. From 1964 to 1966, the dosage of DDT in each of the three districts of the island increased, and now all districts are being treated with more than 118 gms DDT/capita. The percentage of missed houses decreased in all districts from 1965 to 1966 (See Table 2). Despite this evidence of adequate DDT coverage, which was confirmed during this visit, malaria transmission persists. Table 1 shows that neither the API nor the SPR have decreased in any of the three Phuket districts from 1963 to 1966. Why this low level of transmission persists despite adequate residual spraying with DDT is a question that can be answered only by further detailed epidemiologic and entomologic study.

One direction that this study might take is suggested by the data presented in the age and sex distribution of ACD slides and positive cases (Table 11). A male to female ratio of positive cases of 9:1, with 70% of all cases occurring in males aged 15 to 39 despite the fact that only 23.5% of the ACD slides and 19.3% of the population are in this age group, has already been noted. This suggests that the working age male is at special risk of contracting malaria on Phuket. The PCV entomologist in Region 4 supplied the evidence in the following table (Table 18) that there is a significant and increasing trend towards outdoor biting of the vectors on Phuket.

Susceptibility tests made on Phuket vectors thus far have shown that all species are still highly susceptible to DDT. Those specimens caught resting and biting have shown a high mortality rate after 24 hours.

Facts, then, already available with regard to Phuket are that (a) malaria transmission persists despite virtually complete DDT coverage in the absence of DDT resistence, (b) that working age males 15 to 39 years are at special risk, and (c) night-outdoor biting is more common than indoor biting. Knowing that the principal occupations of Phuket are rubber tapping and tin mining, and that a high percentage of this work is done at night, it is tempting to hypothesize that transmission persists because working age males are being bitten by the vector while working out-of-doors at night. Epidemiologic and entomologic confirmation of this hypothesis needs to be sought during the peak transmission season. Mass blood surveys of rubber tappers and tin miners, compared with matched surveys of occupational groups not at this hypothetical risk might be compared, and parallel attempts could be made to trap vectors at rubber tapping and tin mining sites. If this hypothesis proved correct, a strong argument could be advanced that transmission on Phuket would not be interrupted by residual spraying with DDT as the only method of attack. An immediate trial of alternative supplementary methods of attack would then be warranted.

TABLE 18

SUMMARY OF ENTOMOLOGICAL WORK IN PHUKET PROVINCE

		No. mosquitoes trapped/man/hour	
		Indoors	Outdoors
May, 1964	A. maculatus	0	0
	A. balabacensis	0	0
	A. sundaicus	.008	0
August, 1965	A. maculatus	.009	.120
	A. balabacensis	0	0
	A. sundaicus	.301	.280
April, 1966	A. maculatus	.011	.036
	A. balabacensis	0	.006
	A. sundaicus	.115	.059
June, 1966	A. maculatus	.037	.028
	A. balabacensis	0	.148
	A. sundaicus	0	0
July, 1966	A. maculatus	.017	.325
	A. balabacensis	0	.012
	A. sundaicus	0	0
December, 1966	A. maculatus	.066	.116
	A. balabacensis	0	.033
	A. sundaicus	0	0

REGION 5 ZONE 7

NOTES ON THE CANTON OF SAMKHOK

Because of time limitations an in-depth analysis of Region 5 was not feasible. Instead, two team members traveled to the zone office of a problem area and discussions were held both there and at the Region 5 office with the Region 5 Director.

Region 5 consists of 22 provinces surrounding and including the municipality of Bangkok. The notable feature is the presence of the alluvial central rice plain which is criss-crossed by canals. The population in this area is, in general, more prosperous than that in the rural areas in north and northeast Thailand. Much river and canal traffic passes through this plain going to and from Bangkok.

Region 5 until recently had been believed to be non-malarious and no formal attack measures have been used. At the present time NMEP activities in this area consist primarily of ACD surveillance. This has shown that the canton of Samkhok had the highest incidence of malaria in the Region during 1966.

At the Zone 7 office ACD data (MS2 Sept., Oct., 1966) and MS8 forms for Samkhok were reviewed. Most of the cases recorded were believed to have been imported from Pakchong which abuts on Samkhok. Pakchong is a well-known problem area where transmission is continuing at a high rate.

The age and sex distribution of positive cases as found in the canton of Samkhok during 1966 by ACD surveillance are compared with the distribution of ACD slides in Table 1. The failure to document infection in infants can be readily related to the obvious omission of this group from the sampling activities. The result is that the males aged 11 to 20 appear to be a "high risk" group.

While the geographic and socio-economic nature of the area would make population movements an important explanation of the presence of a high incidence of positive cases, one striking finding casts considerable doubt on this hypothesis. In Pakchong, where most of the positive cases found in Samkhok are thought to have become infected, over 80% of all the malaria infections are due to P. falciparum. In Samkhok, however, 157 out of 158 cases in the canton during 1966 were due to P. vivax. This species difference makes the contention that migration from Pakchong is responsible for the great majority of positive cases in Samkhok very questionable, if not an untenable presumption. The more logical and obvious explanation is undoubtedly P. vivax transmission in Samkhok.

Another reason advanced in the past for presuming Region 5 to be non-malarious is the absence of A. minimus and A. balabacensis, the common malaria vectors in Thailand. However the SEATO radical research group has recently demonstrated sporozoites in A. aconitus which is a prolific breeder in the area, particularly in the many brickfields.

Spraying with DDT in this area started this year and was to be completed in April. The results should be closely followed. It should be noted that a full attack phase as practiced in other

parts of Thailand would be difficult in Region 5 because of the relative sophistication of the populace and geography.

ACD surveillance needs to be strengthened in order to define the localities where transmission is taking place. This knowledge would be of major importance in a focal attack program if the usual comprehensive house spraying proves impractical or unacceptable.

TABLE 1
AGE AND SEX DISTRIBUTION OF ACD SLIDES
AND POSITIVE CASES
REGION 5 - CANTON SAMKHOK

Age Group	Sex	% ACD Slides	Percent Positive Cases
0-11 mos.	M	0.0	0.0
	F	0.0	0.0
12-24 mos.	M	0.9	0.0
	F	0.5	0.0
2-10	M	7.9	16.5
	F	8.8	15.2
11-20	M	11.2	25.4
	F	12.4	13.9
21-30	M	4.4	4.4
	F	5.8	5.7
31-40	M	4.3	2.5
	F	6.3	3.8
41-50	M	4.7	3.8
	F	9.5	1.9
>50	M	11.9	4.4
	F	11.2	2.5

APPENDIX I

TERMS OF REFERENCE - PURPOSE AND SCOPE OF MALARIA PROGRAM REVIEW

Purpose: To provide a service to a country program by further defining its strengths and needs. To obtain a more adequate understanding of how NCDC's technical resources can best be utilized to achieve eradication.

Scope of Review: The reviews will be basically field-oriented. They will examine in detail and may re-work available field data relating to progress towards malaria eradication. They will investigate:

1. The reported overall progress towards malaria eradication.
2. The trends of malaria prevalence and incidence, as reported, for selected population units.
3. The existing reporting systems to analyze the adequacy of:
   a. data collection
   b. the communication of data from level to level within the program's operational structure
   c. the methodology used to compile and collate data
   d. the interpretation of malaria data
4. Efficiency and effectiveness of data utilization.
5. The validity of selected malaria field data.
6. The adequacy of the surveillance activities including case detection, treatment, investigation and follow-up.
7. The quality and appropriateness of attack measures.
8. The response of malaria to attack measures and examine the relationship of that response to the quality and the type of attack measures used.
9. The epidemiologic factors which characterize the distribution and incidence of malaria, with particular emphasis on those areas where the response of malaria to attack measures has been unusual.

The review will provide the following to the AID Mission:

1. Provide objective analysis of the progress of the program towards malaria eradication and of the factors influencing that progress.
2. Provide an analysis based on factual data of those components of the malaria program directly concerned with interrupting transmission and monitoring the response of malaria to attack measures.
3. Attempt to demonstrate, where applicable, specific benefits to be derived by epidemiologic approaches to the analysis of malaria data.
4. Provide methodologies for validity checking of field data.
5. Provide an objective, independent technical auditing function for the program.
6. Establish a method of review which will serve as an initial point in a series of reliable, and objective reviews to indicate the progress of the program.

APPENDIX II

ITINERARY OF THE TEAM

March 5-6	Team assembled in Bangkok
7	Bangkok - Meetings with Director of USOM and with PHS Chief Malaria Advisor and staff; meeting at SEATO Medical Research Laboratory.
8	Meetings at Ministry of Health with Director and staff of NMEP.
Dr. MacKenzie and Dr. Chin	
March 9	To Phrabuddhabhat, Region 1 Headquarters, Examination of data
10	Phrabuddhabhat - District and village visits
11	To Pakchong, Zone Headquarters, Examination of data and village visit
12	To Khon Kaen
13	To Khon Kaen - Regional Headquarters and Zone Office, Examination of Data; hospital visit - Dr. Chin
14	Regional Headquarters; p.m. by train to Bangkok
15	a.m. arrive Bangkok; p.m. by air to Chiangmai
16	Region 2 Headquarters; Village visit
17	Headquarters and Zone Office examination of data, Hospital visit - Dr. Chin p.m. return to Bangkok by air
18	Bangkok
Dr. MacKenzie	
March 19	Bangkok to Songkhla by air
20	Haadyai Zone Office : examination of data and visit to villages in district
21	Regional Headquarters and Zone Headquarters, Examination of data; Visits to hospitals in Songkhla and Haadya
22	Return Bangkok by air
23	Bangkok
to 31	In Bangkok; Visit to Samkhok, Region 5
Dr. David Holden	
March 9	To Songkhla by air; visits in Region 4
to 22	To Bangkok by air
23	To Sriraja, Region 5
25	Return to Bangkok
Dr. William Chin	
March 20	To Phrabuddhabhat and Pakchong
March 20	To Phrabuddhabhat and Pakchong; Review of Zone Pakchong
to 25	Return to Bangkok

Dr. Marc LaForce	
March 9	To Khon Kaen by train; review of Region 3
to 25	Return to Bangkok by train
31	Visit to Samkhok, Region 5
Dr. John Mueller	
March 9	To Chiangmai; review of Region 2
to 25	Return to Bangkok by air
March 26 to March 29	Team Meetings and Study of Data
March 30	Meeting with the Minister of Health: Meeting with Director and Headquarters Staff of NMEP in Bangkok
March 31	Meeting with the Director of USOM and Staff

APPENDIX III

EXTRACTS FROM THE THAILAND ENTOMOLOGICAL REPORT BY DR. DAVID D. BONNET

A. Introduction.

At the request of the Chief Malaria Advisor (USPHS) to the National Malaria Eradication Program of Thailand and with concurrence of the Deputy Under Secretary of Health responsible for the Malaria Eradication Program, a review of the entomological activities was carried out from the 15th of February to 3 March 1967.

The review consisted of visits to locations where entomological work is being carried on, review of data collected and discussions with persons involved.

B. Conclusions and Recommendations.

1. The National Malaria Eradication Project has recognized the need for organized entomological work by the establishment of the Headquarters, Region and Zone positions for entomological workers. However, the work presently being done, is routine classical entomological activities with ill-defined goals. It is recommended that the National Malaria Eradication Project re-examine the objectives of the current entomological work and relate it to the immediate need of the malaria eradication effort.

2. The activities of the entomological effort at all levels should be re-evaluated to determine whether the responsibility of each level is being carried out, determine if duplication of effort is occurring (e.g. susceptibility testing at both regional and zonal level) and whether too diverse and heavy a workload has been assigned to the zonal teams. This review of responsibility and workload should lead to the preparation of specific job descriptions separating supervisory activities, verification of identification, and validating the scientific accuracy of the reports at the Regional level from the zonal field worker's task of gathering mosquito data with specified techniques and procedures. The multiplicity of forms is discouraging. Forms should be as simple as possible and designed to show results that can be readily interpreted. (See #4 below)

3. The use of experimental huts to gather basic entomological data is sound if properly located in relation to mosquito sources and malarious areas and when properly constructed and utilized. The experimental hut at Loey is too large, has too many light areas for mosquitos to escape, the window traps, with the black cloth panels, are improperly designed, and it is doubtful if the experimental hut at Loey will provide data that is of any significance under the present conditions. Consideration should be given to relocating the hut in an area where malaria occurs, mosquitoes are abundant and with proper design. The experimental hut at Ratthaphoom with small window traps, entry louvers and tight construction could serve as a prototype for construction of future experimental huts.

The purpose of spraying the experimental huts with DDT does not seem rational unless one has an unsprayed experimental hut as a control. It is questionable if one can compare data gathered before spraying one year, with data after spraying another year, unless one has a control. The use of experimental huts, as this writer sees it, is to provide a typical unsprayed house, where one can study the domiciliary habits of the various species for comparison with possible excito-repellancy or behavior changes in regard to sprayed houses.

Clearly, the objectives of using experimental huts must be determined and the relationship to malaria eradication defined. To date, the data obtained from the experiment are too few to make a meaningful analysis.

4. The forms used for recording mosquito collection data have been reviewed and an attempt made to relate the information gathered with the malaria eradication goal.

All data gathered should be used to provide an answer to a specific question. If other information can be arrived at incidently to the primary goal, this is a bonus.

In a time-limited program, such as malaria eradication, one cannot afford to inefficiently gather data for the sake of gathering data. Every effort must be critically planned and analysed to determine if the effort will contribute to the ultimate goal of eradication.

Basic research is a luxury that cannot be justified or approved in an operational activity such as a Malaria Eradication Project. The concern of the entomologist in malaria eradication is applied research to answer specific problems.

In Thailand, the SEATO laboratory is equipped to do basic studies on the vectors of malaria. Close coordination should be maintained, information exchanged and steps taken to insure the work is complementary and not a duplication.

Although data for an entire year have been made available to the writer, he is at a loss to relate the results to any clear cut problem in malaria.

5. The applied research done with respect to bedbug control with malathion and the study on the effect of DDT on silkworms are examples of the type of applied research which one can readily see contributes directly to the progress of malaria eradication.

6. In reviewing the reports of both current and previously reported entomological work in Thailand, it is obvious that results previously reported have not been consulted and the results obtained earlier are not being utilized. In fact, needless repetition has been in some cases resorted to. Furthermore, the reports (Scanlon 1965) indicate the peak biting time to be from 2300 to 0300, and yet the present night-time catches are between 2000 and 2400.

7. The studies of the habits of people at night appear to be most significant, but must be carried much further. It is suggested that a well designed program of interview of several areas be carried out to determine the degree of night time activity and exposure to vectors, the incidence of malaria in these people in relation to their degree of exposure, determine degree of biting during times of exposure.

It is believed that the most useful information for malaria eradication will be the concentration of studies on the following.

A. Mosquito Relationship to Man
   1. Time of biting
   2. Place of biting (indoor-outdoor)
   3. Frequency of biting
B. Mosquito Relationship to Parasite
   1. Infectibility
   2. Longevity (live to "infective stage"?)
   3. Size of the parasite reservoir
C. Mosquito Relationship to Insecticide
   1. Susceptibility
   2. Irritability
D. Mosquito Relationship to Structure
   1. Entering
   2. Resting - exposure to insecticide
   3. Time of departure after feeding

In Summation:

a. The entomological activities should be more closely related to malaria eradication goals.
b. Planning of entomological studies related to the achievement of these goals should be carefully analyzed.
c. Applied research in the problem areas is distinctly needed, but should be pointed toward the key problem of when and where transmission occurs and not to the presence or absence of vector species.
d. In areas, where the anopheline vectors are not known, special studies might be considered to determine the transmitter of malaria.

Malaria Vectors and Vector Behavior

A number of the anopheline species found in Thailand (see checklist) serve as malaria vectors in other countries, but so far only a few are confirmed vectors here. In order of importance, they are A. minimus, A. balabacensis, A. maculatus, A. sundaicus. Others are suspected but as yet unproven, notably A. campestris and A. philippinensis.

A. minimus is the principal vector in Thailand due to its distribution, domesticity, and density, and has been demonstrated to harbor sporozoite infections in widely separted localities. It is the predominant vector in areas of foothills. Artificial channels or natural streams with slow-flowing, fresh, clean water and grassy edges are its favorite breeding places. It can be regarded as a vector of malaria in all localities where it occurs even in very small numbers.

Thus far it has been found that the range of A. minimus overlaps that of A. balabacensis fairly completely, except in the southern part of the country (see map). In jungle areas (usually associated with hills) A. balabacensis and A. minimus both occur and take part in malaria transmission, and sporozoite infections have been revealed in these species in various localities where they have both been collected. However, A. balabacensis does not occur in areas devoid of jungle. This species, unlike A. minimus, breeds in heavily shaded, standing water pools which may contain a considerable amount of organic matter. Breeding places include bedrock depressions and other basins in those portions of streambeds not occupied by running water, and isolated smaller collections of water in jungle pits.

A. balabacensis does not show the same adaptability to domestication as A. minimus. Diurnal searches in unsprayed houses may reveal A. minimus resting, but A. balabacensis retreats to the jungle, and its daytime resting habits are almost unknown. However, night-time catches may reveal significant numbers of both species in and around human habitation, biting man as well as resting on walls, roof, eaves, and other objects indoors, and on the underside of raised house floors. Both of these species may be collected at night from dusk to dawn, with a considerable variation in hours of peak activity in different parts of the country. Nighttime biting and resting are essential measurements of density. These two species have been collected by searching indoors in sprayed houses only in very small numbers, and the 24-hour survival rate of those few taken in window traps and in the act of biting man inside sprayed structures has been very low.

The density of vectors biting man is usually much higher outdoors than indoors in sprayed areas. The social habits of villagers after dark may support the suspicion of outdoor transmission in some areas where malaria persists in spite of a properly executed eradication program.

Of the other confirmed vectors, A. maculatus has been found to harbor sporozoite infections only in the locality of Waeng, Narathiwat Province, in the southernmost part of Thailand. However, it is a widely distributed species which may attain high densities during certain seasons. A. sundaicus occurs only in the coastal areas of the country, and has been found with sporozoites in 3 localities (see map). Daytime searches are convenient for density estimations of this species.

Susceptibility tests done in several localities revealed no resistance to DDT. The LC50s of specimens kept for 24 hours after a one-hour exposure period were approximately 0.5% for each of the above four vector species.

Two other species, A. campestris and A. philippinensis, are suspected on epidemiological grounds. The former is a suspect in the central (lowland) plains provinces around Bangkok, the latter in some provinces in the northeastern part of the country as well as the lowland plains area.

Research projects on other possible vectors by organizations here include field mosquito dissections and experimental infections. They are done by SEATO Medical Research Laboratory and the School of Tropical Medicine and Hygiene.

Entomological Activities of the NMEP.

The activities of the Entomology Section are divided into three levels: central headquarters, region, and zone.

Staff of the central headquarters is concerned with overall technical supervision, direction, and assessment of the entomological situation in the country in relation to malaria transmission and effectiveness of spray operations. Laboratory staff at headquarters consists of one assistant entomologist and two technical aides. Functions of the laboratory include: a reference source for other laboratories and field workers, checking the identity of mosquito specimens sent from the field, acquisition and maintenance of a collection for teaching and reference purposes, and operational research. The staff of a mobile team operating from headquarters consists of a senior entomological technical assistant and three technical aides. The team is used for special investigations, susceptibility tests in some localities, and verification of entomological records of the other levels.

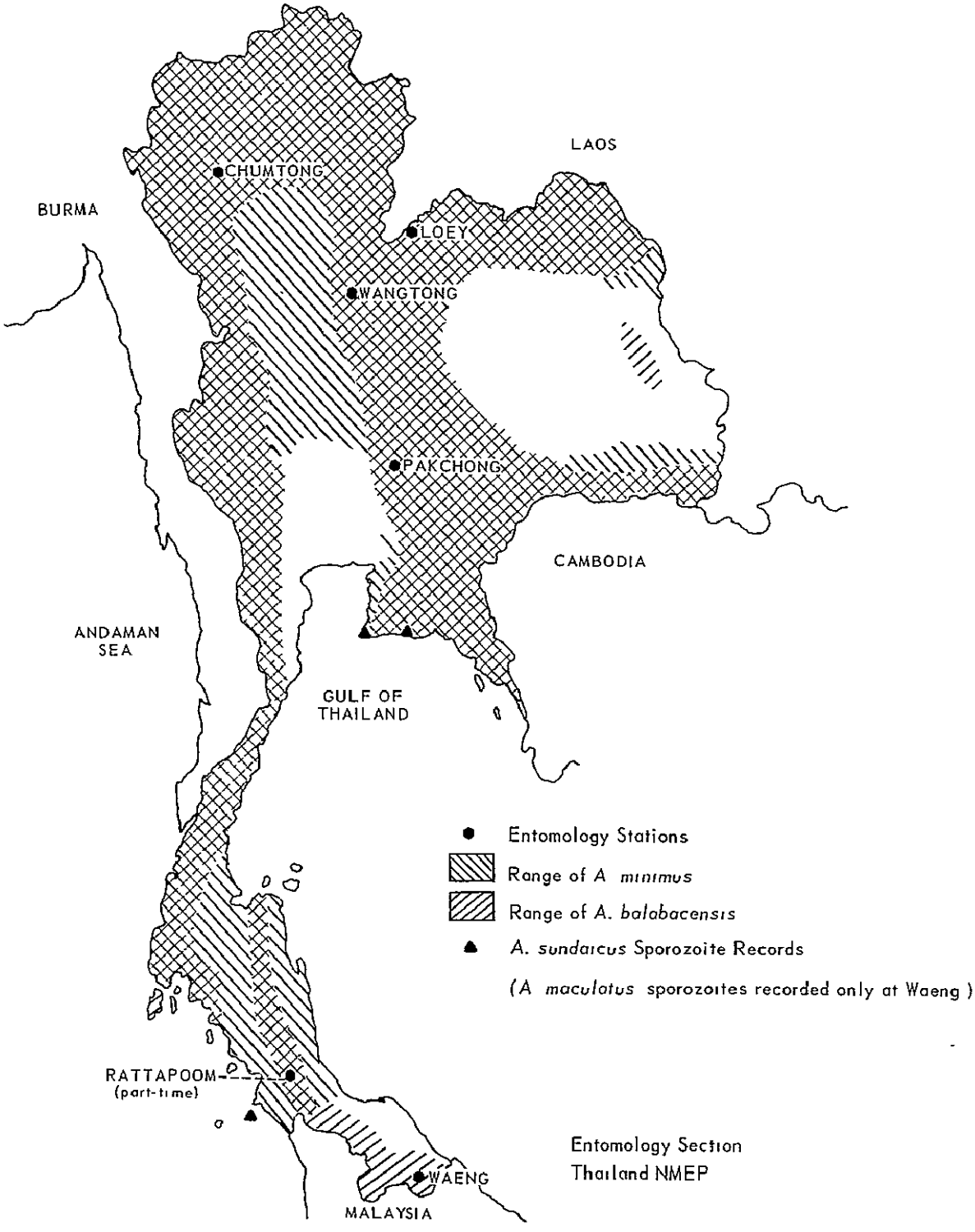
Four out of the five malaria administrative regions in the country have attached to them an entomological team consisting of a senior entomological technical assistant and four technical aides. These teams are responsible for making investigations in areas wherever required, and performing susceptibility tests on vectors. In addition, technical supervision to the zone level and some laboratory duties have been assigned to them.

Five full-time entomology stations and one part-time station are maintained in localities representative of the recognized malaria vectors, each with a staff of one entomological technical assistant and four technical aides. Their duties are to collect data on a continuous basis which serve as indices of program effectiveness. The localities, listed with known principal vectors influencing them, are: 1) Pakchong in the Upper Central Region, minimus and balabacensis; 2) Loey in the Northeast Region, minimus and balabacensis; 3) Wangtong in the Northern Region, minimus and balabacensis; 4) Chomtong in the Northern Region, minimus; 5) Waeng in the Southern Region, maculatus; 6) Rattapoom in the Southern Region, maculatus and balabacensis. Pakchong, Loey, Waeng, and Rattapoom include window trap collections as part of their daily routine.

Focus investigation teams at the zone level have duties which include the investigation of entomological and other aspects of persistent transmission within their zone. Routine observations are maintained in one or two villages by these teams. The observations are of the same nature as those made at the six entomology stations, but usually on a basis of only two nights per village per fortnight.

Five U.S. Peace Corps Volunteers, qualified in entomology, are attached to this section. One is stationed at the national headquarters and one each is stationed at four out of the five regional headquarters.

THAILAND
DISTRIBUTION OF MALARIA VECTORS
AND LOCATION OF ENTOMOLOGY STATIONS



CHECKLIST OF ANOPHELINE MOSQUITOES OF THAILAND

1. *A. aconitus*
2. *A. aitkeni aitkeni*
3. *A. aitkeni bengalensis*
4. *A. albotaeniatus*
5. *A. annandalei interruptus*
6. *A. annularis*
7. *A. argyropus*
8. *A. asiaticus**
9. *A. baezai*
10. *A. balabacensis balabacensis*
11. *A. balabacensis introlatus*
12. *A. barbirostris*
13. *A. barbumbrosus*
14. *A. brevipalpis*
15. *A. bulkleyi*
16. *A. campestris*
17. *A. crawfordi**
18. *A. culicifacies*
19. *A. donaldi**
20. *A. filipinae*
21. *A. fluviatilis*
22. *A. fragilis**
23. *A. gigas formosus*
24. *A. gigas sumatranus*
25. *A. hackeri**
26. *A. hodgkini*
27. *A. indiensis*
28. *A. insulaeflorum*
29. *A. jamesi*
30. *A. jeyporiensis jeyporiensis*
31. *A. jeyporiensis candidiensis*
32. *A. karwari*
33. *A. kochi*
34. *A. lesteri*
35. *A. letifer*
36. *A. maculatus maculatus*
37. *A. maculatus willmori*
38. *A. majidi*
39. *A. minimus*
40. *A. montanus*
41. *A. nigerrimus*
42. *A. pallidus*
43. *A. palmatus*
44. *A. pampanai*
45. *A. peditaeniatus*
46. *A. philippinensis*
47. *A. pollicaris**
48. *A. pujutensis**
49. *A. pursati*
50. *A. ramsayi*
51. *A. roperi**
52. *A. riparis macarthuri*
53. *A. separatus*
54. *A. sinensis*
55. *A. sintonoides*
56. *A. splendidus*
57. *A. stephensi*
58. *A. subpictus subpictus*
59. *A. subpictus malayensis*
60. *A. sundaicus*
61. *A. tessellatus*
62. *A. umbrosus*
63. *A. vagus*
64. *A. varuna*
65. sp. n. (*aitkeni* group)*

*Recent records of SEATO MRL, not those of NMEP or of authors.
(From personal communication with Dr. Douglas Gould.)

APPENDIX IV

SURVEILLANCE OPERATIONS EXTRACT FROM THAILAND

NMEP PLAN OF OPERATIONS - JULY 1965

4. Surveillance Operations

Detailed instructions on surveillance techniques, reporting, etc., based on the following principles, will be issued in the form of a separate manual on evaluation.

4.1 Active case detection:

(a) House to house visits carried out by full-time personnel trained in surveillance procedures. The visits will be carried out at monthly intervals, according to an advance time schedule.

(b) Collection of a thick blood film from every fever case, and from those persons giving a history of fever during the past 30 days and from newcomers.

(c) Presumptive treatment with a single dose of 600 mg. Chloroquine base and 50 mg. Pyrimethamine for adults and proportionally lower dosages for children.

4.2 Passive case detection will include the collection of blood slides from all fever patients attending hospitals, clinics, rural health centres and other medical institutions. The services of voluntary collaborators such as school teachers, village headmen, community leaders, etc., will also be enlisted for the collection of blood slides from fever cases and the administration of presumptive treatment. Special arrangements will be made for the speedy examination and communication of results of blood collected by the passive case detection agencies.

4.3 All slides will be examined within 7 days from the date of collection. Cross checking of 9% of the negative slides and 75% of positive slides by the Regional laboratories and 1% of the negative slides and 25% of positive slides by the Central laboratory. Also 10% of all checked slides from the Regional laboratories will be re-checked by the Central laboratory.

4.4 Primary epidemiological investigation will be carried out on all positive cases, within four days from the date of examination of the slide by the Sector Chiefs for the classification of the case according to its sources as per standard terminology recommended by the expert committee on malaria. The investigation in the neighborhood of the positive case or cases will include the collection of blood slides from all the occupants of all houses in a small village with a population up to 200, and from the inhabitants of at least 50 houses in the neighborhood of the positive case or cases in larger communities. Each investigation should yield from 100 to 150 smears per focus in the consolidation phase area.

4.5 Radical treatment of all positive cases detected. All positive malaria cases regardless of species will be treated with a total dose of 1500 mg. of chloroquine administered over a period of 3 days and primaquine for 5 days at 15 mg. per day. All positive cases detected during the

year will receive a follow-up radical treatment during the following year in a month to be designated preferably when the number of cases are lowest.

4.6 In the consolidation phase area, an exhaustive epidemiological investigation will be carried out within 72 hours upon receipt of the result of the primary investigation if the result is considered unsatisfactory, when the area is suspected to be a problem area and/or when there is a persistent focus. Another mass blood examination will be carried out two months after the first mass blood examination.

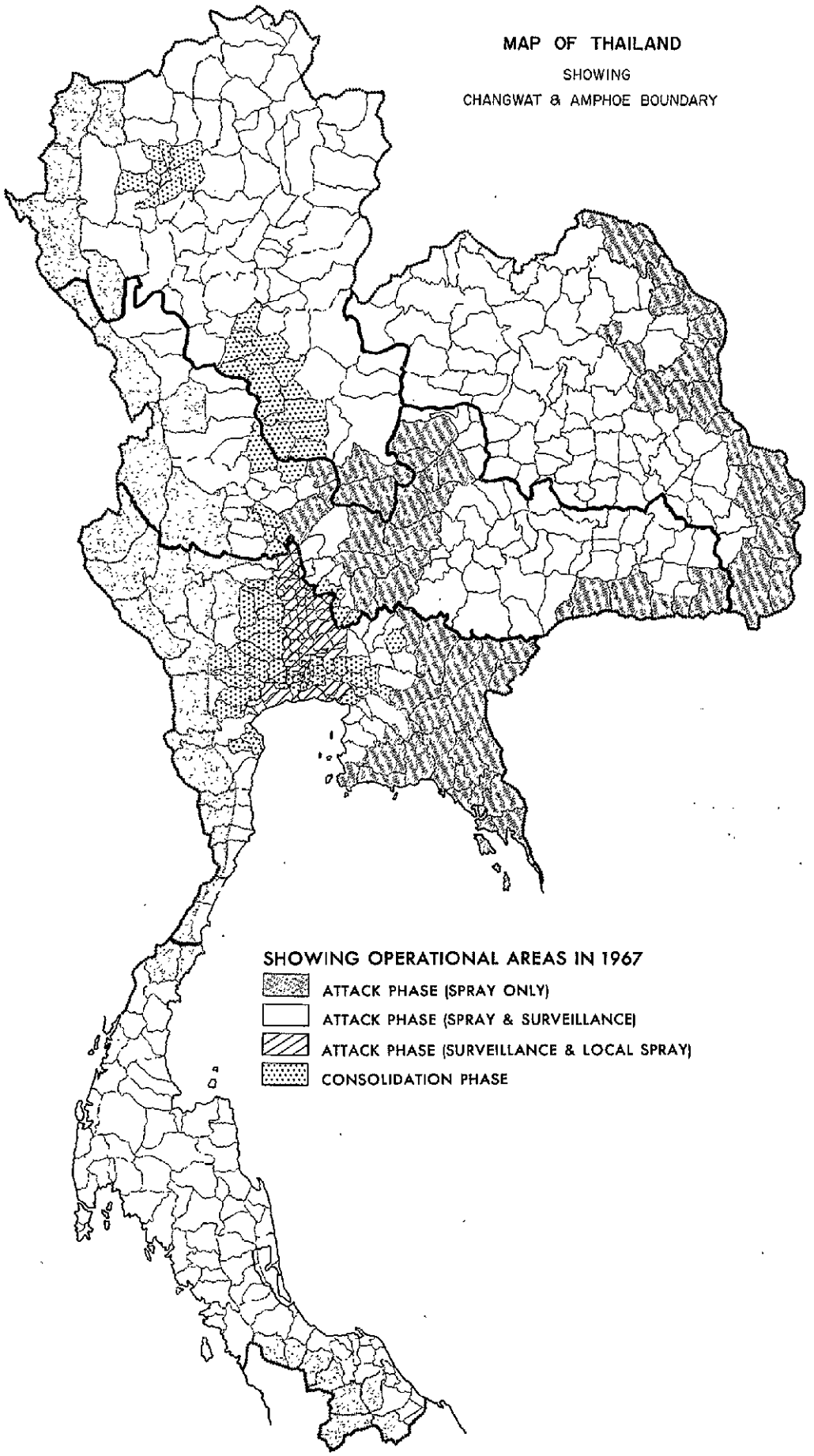
In the attack phase area, this exhaustive epidemiological investigation will only be carried out where the area is being projected for withdrawal of spraying and transmission appears to persist in spite of the measures being adopted.

The exhaustive epidemiological investigation will consist of epidemiological and entomological investigations, investigation into the spraying and surveillance operations and other special epidemiological features of the area involved.

4.7 Follow-up of positive cases. Each positive case will be contacted every month for the first 3 months and thereafter at three monthly intervals for a total period of one year, and a blood smear will be taken by the surveillance agent at these specific times on the occasion of his monthly visit.

4.8 In the consolidation phase areas, remedial measures will include spraying of the entire locality where a focus of transmission is encountered or where around the indigenous case there are vectors in dangerous numbers irrespective of the classification in the case. In the attack phase areas, re-spraying may be required. Spraying will be carried out at a dosage of 2 gm. per sq. m. on the totality of the houses constituting the locality and in any case for a radius of at least 750 meters from the house of the case. If cases in considerable number are detected in scattered localities in the same sector resulting in an estimated yearly prevalence rate of 0.01% or above, the entire epidemiological area of that sector will be sprayed. Foci of transmission will need re-spraying the following year. Other remedial measures such as chemoprophylaxis, mass radical treatment, larval control methods may be taken into consideration should epidemiological investigations indicate their need.

APPENDIX V


MAP OF THAILAND
SHOWING
CHANGWAT & AMPHOE BOUNDARY
SHOWING OPERATIONAL AREAS IN 1967
ATTACK PHASE (SPRAY ONLY)
ATTACK PHASE (SPRAY & SURVEILLANCE)
ATTACK PHASE (SURVEILLANCE & LOCAL SPRAY)
CONSOLIDATION PHASE