

## Chapter VIII

# MALARIA SURVEILLANCE

### DEVELOPMENT OF THE MALARIA SURVEILLANCE SYSTEM

Before the initiation of the malaria control program in 1952, *An. minimus* was found in 166 townships. As late as in June 1959 the vector species was still found in 55 townships, though in much smaller numbers. The malariometric surveys such as the island-wide simultaneous parasite surveys among pre-school children and the island-wide spleen survey among school children, indicated the existence of residual malaria, but could not measure the exact amount.

In Nantou county, a network of 17 township malaria surveillance stations was experimentally organized as early as December 1954. This scheme was expanded in September 1955 to 89 stations and remained in operation until October 1957. Each station had one health station technician who worked 10 days a month to make quarterly house visits for case detection in the most malarious area in his township, which had a population of 5,000-6,000. Blood smears were prepared from all infants, all children born after the initial spraying (or POC for post-operational children), and fever cases in other age groups. Any positive infant or POC was highly indicative of new transmission. *P. falciparum* infections were also considered important evidence of recent transmission, as this species is believed to be the most short-lived (9-12 months) of human plasmodia. All new infections detected (19 POC and 143 *P. falciparum* infections) were investigated to determine the source of infection. Four transmission foci were discovered—one in 1955, two in 1956, and one in 1957, but none of them was eliminated by this surveillance scheme.

To solicit the spontaneous case reporting by doctors, malaria was proclaimed a notifiable disease by the Provincial Government in July 1955. The detailed procedure of case reporting and treatment was published in a May 1956 issue of the *Taiwan Provincial Gazette*. As many as 610 malaria cases were found among 870 reports received from May 1956 to December 1959. However, the majority of these cases had already been detected by the township malaria surveillance stations.

To complement the static township malaria surveillance scheme, 10 mobile malaria detection teams were organized in October 1956. Each team comprised one microscopist/team-leader (TAMRI personnel) and four blood collectors (one TAMRI) and three local health personnel). They collected blood smears from

infants, POC and fever cases among other age groups, and examined blood smears as they moved. After surveying one county, the TAMRI personnel moved to another, leaving the local health personnel to resume quarterly house visits in the villages designated for the township malaria surveillance. It took 13 months for the mobile teams to make just one complete round of case detection in the formerly hyperendemic areas. The teams detected 133 additional cases, including 21 POC and 33 *P. falciparum* infections, as well as three malaria foci.

The combined efforts of township surveillance stations, mobile detection teams, and the reporting doctors revealed the existence of residual foci of infections in 84 townships with a total of 1,284,200 population. With this information, together with the results of an island-wide entomological investigation, it was possible to divide the whole province into areas of graded epidemiological potential for application of appropriate surveillance measures -- active malaria foci, potential malaria foci, formerly malarious areas, and non-malarious areas. On this principle, a prototype stratified malaria surveillance was carried out from November 1957 to June 1958. The emergency countermeasures in the active foci were implemented by the TAMRI personnel, who had just been released from the island-wide spraying operation terminated in October 1957. Case detection measures of different intensity and case treatment in all other areas were carried out by 284 local health personnel (part-time for this assignment) complemented by 20 full-time blood collectors employed with the township funds. In an eight-month operation, the prototype stratified surveillance discovered 199 cases, including 36 POC and 68 *P. falciparum* infections. It detected one more transmission focus while eliminating three out of eight existing ones. The stratified approach was correct but needed more trained technicians to attain adequate continuity in space and time.

#### FULL-SCALE STRATIFIED MALARIA SURVEILLANCE(FSMS)

A five-year malaria surveillance plan, with the objective of achieving malaria eradication from Taiwan by June 1963, was presented by TAMRI on February 25, 1958 for consideration by the Government, WHO and the International Cooperation Administration (ICA) of U.S.A. The plan was approved and an agreement signed by the parties in late May 1958.

It thus became possible for the first time to adopt a malaria surveillance scheme which could concentrate on meeting most of the operational requirements rather than one organized just to suit the limited budgetary resources. The budget for

employing additional full-time field and laboratory workers came from the WHO Malaria Eradication Special Account (MESA), while antimalaria drugs and insecticides were supplied by WHO and ICA, respectively.

The soundness of the surveillance scheme was solemnly challenged by the influx of thousands of refugees, carrying a parasite rate of 11%, from the Sino-Thai-Burmese border area during March - June 1961 (*see* "Operations Kuolei" in Chapter X). These were military evacuees and were widely distributed in Taiwan by December 1962, including 57 villages in 35 townships of 15 counties. Thanks to prompt and well-coordinated actions taken jointly by the civilian and military surveillance services, no resumption of local transmission took place.

The surveillance program was prolonged by one and a half years to December 31, 1964 to intensify passive case detection in certain localities, to provide adequate information for certification of eradication and to arrange gradual but orderly transfer of the entire malaria surveillance responsibility to the regular health services. To heighten the morale of voluntary collaboration and other personnel involved in passive case detection, the Council for United States Aid (CUSA) provided funds for paying bounties during this extended period.

### **Stratification of Surveillance Areas**

Epidemiologically sound stratification of surveillance areas according to residual malaria potential and selection of adequate operational measures for each stratified area were fundamental for achieving the highest efficiency with minimum cost.

By the end of 1957, the hyperendemic areas had already received five rounds of annual spraying, the mesoendemic areas three rounds, and the hypoendemic areas one round. With the exception of a few residual foci in remote rural localities, malaria transmission was interrupted long enough for the majority of residual malaria infections (especially those due to *P. falciparum*) to undergo natural cure.

Consequently, the epidemiological potential was very much reduced in most of Taiwan. The higher the pre-spraying endemicity, the more marked was the reduction. Nevertheless, the pre-spraying endemicity still signified the corresponding degree of epidemiological potential in late 1950s, and was taken into consideration when five surveillance areas were defined in 1958. The size of each surveillance area in the following years, however, was adjusted annually based on the results of

operations in the previous two to three years, to cope with the changing epidemiological situation.

The use of pre-spraying malaria endemicity -- an immutable historical fact -- in the definition of surveillance areas was soon found to be rather cumbersome, causing the area definition in later years to look rather disorderly.

The number of surveillance areas was begun with five, increased to seven, was decreased to six and ended up with four. Table 38 shows the annual change of the surveillance areas from July 1958 through December 1964; Map 12 depicts the areas defined for stratified malaria surveillance for the years 1963 and 1964.

### **Protocol for Surveillance Activities**

The full-scale stratified surveillance commenced July 1958 to substantiate the eradication of malaria with adequate case detection coupled with efficient laboratory services, epidemiological operations and remedial measures.

Surveillance measures adopted by the Taiwan MEP may be grouped as follows:

- \* Case detection, including an active approach by the surveillance personnel and a passive approach by local doctors, school teachers and collaborating villagers;
- \* Epidemiological case investigation and follow-up;
- \* Anti-parasite measures, including presumptive and radical cure chemotherapy;
- \* Anti-mosquito measure(DDT house-spraying);
- \* Entomological vigilance;
- \* Remedial measures to transmission foci; and
- \* Vigilance against importation of malaria from abroad, especially among refugees, overseas Chinese (students and others), international exchange experts (agriculturists, engineers, etc.) and so forth.



**Table 38**  
*Areas Defined for Stratified Malaria Surveillance, July 1958 - December 1964*  
 (with population involved in each area)

Initial Name of Area	Initial Definition	FY1959 July '58- June '59	FY1960 July '59- June '60	FY1961 July '60- June '61	FY62/63* July '61- Dec. '62	CY63/64 Jan. '63- Dec. '64
Active malaria foci	Evidence of transmission Overall PR≥2% <i>P. Falciparum</i> rate≥10%	10,000	4,000	2,000	3,500	317,000 <sup>A/</sup>
Potentially malarious areas	Indigenous cases in Previous 2 years	308,000	125,000	105,000	308,050	
	Relapsing or imported cases with <i>An. minimus</i> breeding in previous 2 years		135,000	207,000		
Formerly hyperendemic areas	Pre-spraying Sr≥ 50% with non-indigenous cases	1,210,000	500,000	** 570,000	** 615,800	4,322,000 <sup>C/</sup>
	Pre-spraying Sr≥ 25% with non-indigenous cases		530,000	1,113,000	9,875,650	
Formerly meso- and hypoendemic areas	Pre-spraying SR < 25%; Relapsing or imported cases	1,510,000	1,400,000			
Non-malarious areas	Malaria eradicated; Imported or induced cases	6,600,000	7,350,000	8,450,000		
TOTAL		9,638,000	10,044,000	10,447,000	10,803,000	11,171,000

PR=Parasite rate; SR=Spleen rate.

FY=Fiscal year (July to the following June); CY=Calendar year.

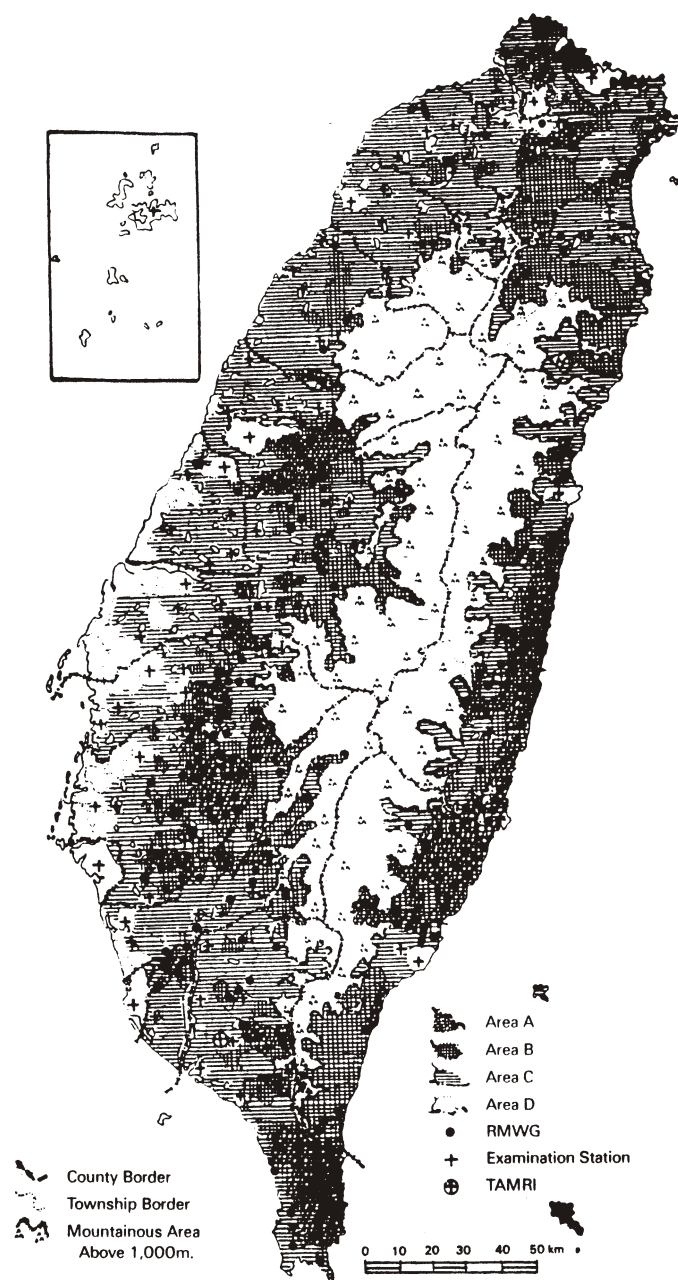
A/=Active foci and potentially malarious; B/=Ex-hyperendemic;

C/=Ex-meso-, hypoendemic (semi-urban); D/=Non-malarious (urban).

\* FY1963 covered only July 1962 - December 1962.

\*\* Formerly malarious areas.

**Map 12**  
*Areas Defined for Stratified Malaria Surveillance, 1963 and 1964*



### ***Case Detection***

With MESA funds made available to the Full-Scale Stratified Malaria Surveillance (FSMS) Program, full-time blood collectors were contracted by TAMRI and assigned to the local health stations at the rate of one per 500 population in Area A, one per 3,000 in Area B, and one per 25,000 to some townships in Area C. Active case detection (ACD) was applied periodically -- monthly, quarterly or annually -- by these blood collectors through visits to assigned localities. Blood smears were taken from everyone in the locality, or from selected groups of people, such as fever cases, infants, military recruits, internal migrants, drug addicts or others. This measure could be far-reaching but lacked continuity in time. When passive case detection in the area was functioning efficiently, its intensity was reduced.

Passive case detection (PCD) was carried out by information posts (hospitals, health and medical services), and voluntary collaborators, *e.g.*, school teachers, policemen, village chiefs and other respected local people. They took blood smears from fever cases and other suspects encountered within their respective sphere of daily contact, using the supplies provided by TAMRI. They were visited regularly by the surveillance personnel in their areas.

Case detection measures were modified almost yearly to cope with the evasive nature of disappearing malaria. Mass blood surveys, initially useful, were in a few years replaced by screening surveys, which were later applied less frequently along with the evolving networks of voluntary collaborators.

Cash awards for reporting cases, introduced in September 1959, were first offered only to doctors; they were later offered to everyone except TAMRI employees. The cash award per microscopically confirmed case, shared by the reporting person, blood collector and examining microscopist, was gradually raised from NT\$300 to the current NT\$2,000 (1989).

Rural (village) malaria vigilance groups (RMVG) were first organized in September 1960(11 groups) in villages where post-spraying transmission was detected. A network of 241 RMVGs with 1,600 volunteers covering the formerly hyperendemic areas was completed in January 1963. Each group consisted of about 10 volunteers working for an average village of 1,000 population. After brief training by a local health technician, the group members took blood smears from recent fever cases and other malaria suspects encountered during their daily contacts. They also helped in case investigation and treatment, active case detection, or in emergency control. Group members received no fixed pay for these services. However, they were

paid travel expenses and per diem for attending discussion meetings and an incentive bounty of NT\$500 per group per month. When a malaria case was detected, the reporting member was awarded a cash prize and a certificate of merit from TAMRI.

Urban malaria vigilance units (UMVU) were established in the five largest cities in July 1960 to (i) coordinate all health and medical services in the city for a concerted search of relapsing, induced or imported malaria cases; (ii) provide prompt microscopic diagnosis of malaria for the doctors practicing in the city ;and (iii) give prompt radical treatment to confirmed cases before their migration to potentially malarious areas. Each UMVU consisted of the city malaria supervisor as the unit coordinator, one or two microscopists and several vigilance assistants selected from district health stations. The vigilance assistants regularly reminded -- by telephone and post-card inquiry -- practicing doctors, school teachers and technicians at medical laboratories and blood banks on the importance of malaria case reporting. These assistants also helped in taking blood smears from malaria suspects and forwarding the smears to microscopists. Each unit received an incentive bounty of NT\$500 a month. The vigilance assistants and microscopists were entitled to their share of any prize for each microscopically confirmed case they helped to discover.

Township malaria vigilance units (TMVU) were established in semi-urban areas not covered by either RMVG or UMVU. The network of 307 TMVUs with 2,800 members was completed in June 1963. Each unit consisted of the township malaria technician as the unit coordinator and several volunteer unit-members, one from each village where practicing doctors or a primary school were located. Unit-members were trained to maintain close contact with doctors and school teachers and to assist in making blood smears. The smears from TMVUs were examined by the microscopists stationed at the health center or at the selected health stations. The selection, training and functions of TMVU members, incentive bounties and cash prize systems were similar to those established for RMVGs. Thanks to the timely reporting of *P. vivax* cases by a TMVU member in Changpin township, Taitung county, the last transmission focus discovered there in September 1964 was eliminated before transmission could go beyond introduced cases. Beginning in September 1963, 30 military malaria vigilance groups, with 170 members, were in operation searching for malaria cases among servicemen and their dependents.

The protocol for case detection activities in 1963 and 1964 are summarized in Table 39 as an example to show the extent of coverage in the surveillance program.

**Table 39**  
*Case Detection Protocol for the 1963 and 1964 Surveillance Program*

Activities	Area A Population 317,000	Area B Population 627,000	Area C Population 4,322,000	Area D Population 5,905,000
<u>Passive Case Detection</u>				
- Private doctors	*	*	*	*
- Medical/health institutest	*	*	*	*
- RMVG	*	*		
- UMVU & TMVU		*	*	*
<u>Active Case Detection</u>				
- Fever case survey at villages and schools	monthly	quarterly		
- Fever case survey at public clinics	monthly	monthly	monthly	monthly
- Fever case survey among conscripts	annually	annually	annually	annually
- internal migrants				
· initial examination	**	**		
□ follow-up	monthly	monthly		
- immigrants from abroad				
□ initial examination	**	**	**	**
□ follow-up	monthly	monthly	monthly	monthly
No. of blood smears to be examined	> 60,000	> 90,000	> 450,000	> 100,000
Annual Blood Exam. Rate	> 20%	> 15%	> 10%	1-2%

\* Blood smears were taken immediately whenever suspected malaria cases or fever cases were encountered.

\*\* Blood smears were taken immediately on arrival of all internal migrants or immigrants, when possible, and followed up monthly by fever case surveys.

RMVG = Rural malaria vigilance group.

□□□□□□□ UMVU = Urban malaria vigilance group.

□□□□□□□ TMVU = Township malaria vigilance unit.





Fig. 67: A mailman delivering blood smears



Fig. 68:  
Preparing blood smears  
for staining





Fig. 69: Staining blood smears

Before the establishment of examination stations (five in the largest cities in July 1960 and 80 more all over the island in November 1962), all blood smears were stained and examined at the TAMRI laboratory, where dedicated microscopists worked under close supervision. From July 1958 to December 1964, a total of 1,023 positives were found among 5,317,920 smears examined by all laboratories, or one in every 5,198 smears. Examining 65 smears a day, an average microscopist would need 80 working days or as long as three months to encounter a positive smear. To discourage lassitude on the part of the TAMRI microscopists, the following steps were adopted: (a) all positive smears were immediately confirmed; (b) 3-5% random sample of negatives were re-examined by senior technicians; (c) one slide positive for simian malaria parasites (*P. inui*) was routinely slipped into each batch of stained smears to be examined by a microscopist in one day; and (d) a cash award system

was introduced in January 1960 to encourage detection of positive smears. The cash award per positive smear varied from NT\$30 to NT\$80 according to the priority order and parasite density of the smear. All positives identified by non-TAMRI examination stations were confirmed and negatives samples were rechecked by the TAMRI laboratory.



Fig. 70: Examination of blood smears  
Source: JCRR

The discovery of a positive smear at a laboratory was immediately announced to the persons and units concerned for radical treatment and for epidemiological investigation to reveal the source and route of infection.

The problem of induced malaria attracted increasing attention beginning in August 1959. Thirty-seven(37) such cases were found from July 1959 to December 1964. All of them were infected with *P. malariae*.

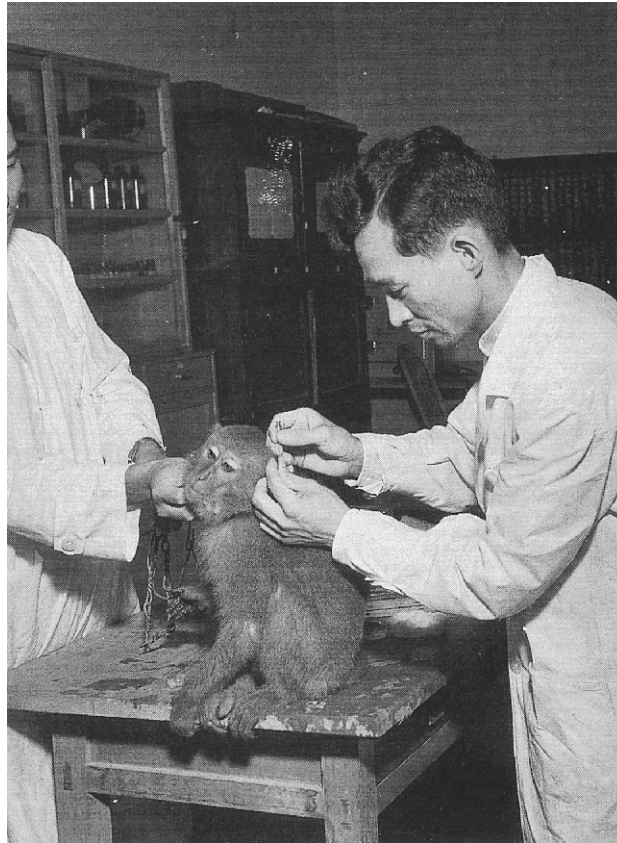


Fig. 71: Preparing blood smears from monkey  
Source: JCRR

### ***Case Investigation***

During the initial surveillance phase when the whole malarious area was still under annual spraying, only infant, POC and *P. falciparum* cases were investigated for the purpose of discovering transmission foci. However, from July 1958 all positives were investigated and followed up for one year. The purposes of this measure were: (a) to reveal the source and route of infection; (b) to determine the possibility of local transmission; and (c) to administer radical cure treatments to the persons infected.

Case investigation was done by TAMRI personnel through its mobile investigation and control teams, each consisting of one senior surveillance supervisor, one microscopist/blood collector, one entomology technician and one engineering assistant/driver (for DDT spraying). Each mobile team was adequately equipped for microscopical examination of blood smears, emergency DDT spraying, administration of antimalaria drugs and entomological studies. After the initial investigation, the cases and their close associates were visited monthly by local surveillance personnel for a period of one year. Similar procedures were also followed in any potentially malarious localities frequented by the malaria cases under investigation.

When a case under radical treatment or monthly follow-up examination moved out of the township for one month or longer, the case was referred to the surveillance personnel of the township to which it had moved. Cases investigated were classified according to the source of infection as indigenous, relapsing, induced, imported, introduced or cryptic, as conventionally categorized.

Epidemiological investigation of cases led to the discovery of 13 transmission foci during the consolidation phase of ME program -- four in FY1959, one in FY1960, two in FY1961, three in FY1962, two in FY1963 and the last one in September 1964.

### ***Treatment***

Malaria cases received treatment at their homes. Prior to March 1959, radical treatment was done with amodiaquine or chloroquine, divided into four doses and given in three consecutive days. Only the first dose was administered by surveillance personnel; the patients were entrusted to take the second dose six hours after the first and one dose in each of the following two days. As many as 35% of cases treated with this method experienced relapses from one to 17 months after treatment, including 20% from one to three months, 12% from four to seven months, and 3% from eight to 17 months. It was in March 1959 that primaquine became available in sufficient quantity for radical treatment in combination with chloroquine. In the new regimen adopted from March 1959, the total dose of chloroquine (30 mg/kg body weight) was divided into four doses and given one dose a day to all confirmed cases irrespective of the *plasmodium* involved. A dose of primaquine (15 mg for an adult) was given daily, from the first day of chloroquine treatment, for five days to *P. falciparum* infections and for 14 days to *P. vivax* and *P. malariae* infections. The patients were not entrusted to self-medicate with these doses. Generally speaking,



treatments were given by the surveillance personnel, but on a few occasions they were administered by collaborators such as school teachers and village chiefs. To confirm a radical cure, a monthly blood examination of the treated person was conducted for a period of one year. However, according to a study made of 392 cases one year after radical treatment, only 19% of them actually received monthly blood examinations for 10-12 months.

A field observation was carried out in August 1958 to learn about side effects associated with the new regimen of radical treatment. A total of 16 newly-confirmed cases (twelve *P. vivax* and four *P. malariae* infections) were selected for domiciliary treatment under supervision. No evidence of side effects justifying discontinuation of medication was noted. Additionally, side effects experienced by 461 malaria cases re-treated with the new regimen were carefully recorded by specially-trained surveillance personnel. These cases (150 *falciparum*, 229 *vivax*, and 82 *malariae*) were old cases; the period elapsed between the original laboratory diagnosis and this re-treatment ranged from four to 42 months. From 27% to 32% of the cases experienced a combination of side effects during the first three days, 16% on the fourth day, 9% to 10% on fifth to sixth day and 3% to 8% from the seventh through the 14th day. This clearly indicated that most side effects were due to chloroquine. After the conclusion of chloroquine administration, marked decrease was observed in such symptoms as dizziness, epigastric distress, headache, diarrhea and malaise. Nausea, vomiting, blurring of vision and nasal bleeding were found in less than two percent of the treated cases and disappeared almost completely from the fifth day. There were practically no differences in the occurrence of side effects between the recent and old cases, or among cases with different species of *plasmodium*.

In view of the poor results of earlier treatment using only amodiaquine or chloroquine, 1,278 cases detected and treated between January 1956 and February 1959 were re-treated with the new regimen from March 1959, although none of them were found to be positive for malaria parasites at the time of re-treatment.

Timeliness of case detection and radical treatment may be judged by the results of epidemiological investigation of the cases detected and treated from March 1959 to March 1960. About 85% of the cases had their first positive smears taken within one month after the onset of a preceding clinical episode, 11% between one to six months, and 4% over six months. The time elapsed between the preparation of the smears and microscopic examination for 52.2% of the cases was within one week, for 35.4% between one to four weeks, for 12.3% between one to six months, and for 0.1% over six months. Only 52% of the cases were given radical cure

treatment within one month of the laboratory diagnosis, 36% between one to six months, and 12% over six months.

### ***Anti-Mosquito Measures***

During the period January 1958 - June 1959, annual DDT house spraying was continued in residual transmission foci, in villages with indigenous cases and /or whit *An. minimus* breeding during the preceding two years, and in the adjacent formerly - hyperendemic areas. From July 1959 to June 1960, DDT spraying was done once every four months in transmission foci and once every six months in parts of the potentially malarious areas. The regular application of DDT spraying and routine suppressive treatment of fever cases in the potentially malarious areas were discontinued in July 1960, because these measures were considered to obscure the presence of transmission foci or reservoirs of infection. This action presented a crucial challenge to the surveillance scheme then in force. In fact, as many as six transmission foci were discovered from June 1961 to November 1962 -- two each in central, southern and eastern Taiwan. The appropriate surveillance measures were usually able to eliminate them in less than 10 months.

The 10:1 mixture of 75% water-dispersible DDT and 6.5% gamma-BHC, previously used for applying a dosage of 2 gm technical grade DDT and 17 mg gamma-BHC per m<sup>2</sup> of surface, continued to be effective in interrupting malaria transmission, as the main malaria vector *An. minimus* was still highly susceptible to DDT. The insecticide mixture also continued to show collateral anti-pest benefit, which helped to maintain a high level of community participation in the sprayed localities.

Bioassay testing on the residual effect of DDT deposit sprayed on walls and surfaces was carried out in September 1958 in northern, central and southern Taiwan. The results indicated that DDT lost its effectiveness quite rapidly on mud walls. The mortality of the anophelines during the first 24 hours after a 15-minute contact with one-month old DDT-sprayed surface was 100%; it dropped to 71.4% with 4-5 month old DDT, and further dropped to 48.5% when the deposit was 6-7 months old. From October 1958, spraying was done at 4-month intervals until interruption of transmission was assured. Table 40 shows annual summaries and analyses of DDT spraying for the period January 1958 - June 1962.



**Table 40**  
*Annual Summaries and Analyses of Spraying Operations*  
*CY1958 - FY1962*

Description	CY 1958 (Jan-June)	FY 1959	FY 1960	FY 1961	FY 1962
Period of spraying - Date started - Date completed	3 March '58 11 June '58	18 Aug. '58 7 June '59	24 Aug. '59 21 June '60	21 July '60 20 June '61	1 July '61 26 June '62
Coverage - No. of structures sprayed - No. of people directly protected	28,474 206,922	45,400 327,574	55,015 397,679	5,799 41,751	1,573 12,849
Total cost of spraying (NT\$) (US\$ equivalent)	1,086,796 (37,411)	1,592,168 (43,765)	2,149,090 (59,073)	237,373 (5,934)	123,134 (3,078)
Per structure analysis - Surface area sprayed (m <sup>2</sup> ) - No. of inhabitants - Technical DDT used (gm)	303 7.27 601	322 7.23 641	298 7.25 594	307 7.20 615	259 8.17 518
Per capita analysis - Surface area sprayed (m <sup>2</sup> ) - Technical DDT used (gm) - Cost (NT\$) (US\$ equivalent)	41.7 82.7 5.25 (0.181)	44.5 88.7 5.35 (0.147)	41.1 82.0 5.43 (0.149)	42.7 85.4 5.69 (0.142)	31.7 63.4 9.58 (0.240)
Surface area sprayed (m <sup>2</sup> ) per man-hour labor of sprayman	313.0	323.0	289.4	335.1	188.4

CY = Calendar year (January - December)

FY = Fiscal year (July - June)

### ***Entomological Vigilance***

To remain alert against the return of *An. minimus*, in terms of population density and geographical distribution, an island-wide entomological vigilance was initiated in July 1958. Monthly systematic anopheline surveys were carried out at 132 fixed stations (reduced to 55 in January 1960) selected at strategic localities throughout Taiwan where the vector mosquitoes had once flourished or where the incidence of malaria was high in pre-spraying days.

In FY1959, *An. minimus* was found breeding in 13 spray-discontinued townships and in 44 spray-continuing townships. The density of *An. minimus* population was extremely low compared with that in the pre-spraying days, even in those townships where this mosquito was still present. However, it was observed that *An. minimus* was returning slowly but steadily in an increasing number of localities.

As a part of epidemiological investigation, an intensive anopheline survey was usually conducted within a radius of 1 km from the house of a positive case. This was done coincidentally with the initial and subsequent parasite surveys. Entomological investigation in suspected transmission foci comprised (a) daytime examination of five houses, including those of positive cases, for the presence of adult anophelines, (b) larval collection at potential breeding places within 1-km radius from the house of positive cases, (c) night-catch of anophelines using animal or human baits, and (d) dissection of anophelines for the presence of sporozoites and for age determination.

The effective duration of DDT deposit on sprayed surfaces was checked by the modified Simon's bioassay test from time to time and in different places. The susceptibility of anopheline mosquitoes to DDT was studied by the Busvine & Nash's test whenever enough specimens were collected. The result of the tests carried out in early 1959 showed LC-50 of 0.2% DDT for *An. minimus* and LC-50 of 13.5% DDT for *An. sinensis*.

In some persistent transmission foci, either extra-domiciliary transmission by a wild strain of *An. minimus* or the outdoor sleeping habit of people was suspected for some time. *An. maculatus* was also suspected as a possible secondary vector. This species was reported only once by Anazawa (1931) as having a gland infection in one specimen. No concrete proof of these suspicions was obtained, and the foci were eventually eliminated by shortening the spraying intervals.

### ***Elimination of Transmission Foci***

Once a transmission focus was identified, an appropriate combination of remedial measures was carried out until complete smear negativity had been obtained for more than three consecutive months. Thereafter the focus area was reclassified as a potentially malarious area and placed under intensive surveillance for two or more years. From September 1960, a group of local voluntary collaborators was organized in each ex-focus area to carry out intensive passive case detection.

Of all 21 transmission foci found and eliminated in meeting the malaria eradication criteria, eight had been discovered while TAMRI was still struggling to establish a foolproof surveillance system. These foci and those subsequently identified usually shared many common characteristics, such as:

- \* localities were in deep valleys or remote newly-settled foothills;
- \* houses in the foci had been inadvertently omitted from the spraying itinerary, or had been poorly sprayed;
- \* population in the foci was sparse, often seasonal and migrant in nature; and
- \* residents in the foci lived in substandard lodging constructed of poor material such as thatched grass, coarsely-woven cane or bamboo, or absorbent mud (see Fig. 72).

Nine foci were controlled in 4-6 months, six in 9-10 months, two in 14-15 months, two in 19-20 months, and one each in 29 months and 35 months. Generally, *falciparum*-dominated foci were controlled in 4-6 months (5.2 on the average), *vivax*-dominated foci in 5-35 months (15.2 on the average), and *malariae*-dominated foci in 9 months.

The combined use of pyrimethamine and chloroquine in mass suppressive treatment began in October 1958; that of primaquine and chloroquine in radical treatment began in March 1959. Before October 1958, it took an average of 13.3 months (ranging from 5-35) to control a transmission focus, compared with 9.1 months (ranging from 4-15) for the period after September 1958.



Fig. 72: Charcoal workers live under precarious conditions; temporary huts sometimes went unnoticed and unsprayed.

### ***Control of Imported Cases***

Importation of malaria from abroad assumed considerable importance as early as FY1960 when five of 105 cases discovered in the year were proven to have contracted their infection abroad. All of them were overseas Chinese who had come to Taiwan from countries in the Western Pacific and Southeast Asia regions.

A survey carried out from February 26 to March 31, 1960 revealed that there were 7,076 overseas Chinese students enrolled in 64 schools of various grades -- 2,481 (35.1%) from Hong Kong and Macao; 1,235 (17.5%) from Vietnam; 799 (11.3%) from Indonesia; 587 (8.3%) from Malaysia; 454 (6.4%) from Korea; 395 (5.6%) from Thailand; 170 (2.4%) from Singapore; 166 (2.3%) from the Philippines; 150 (2.1%) from Cambodia; 148 (2.1%) from North Borneo; 72 (1.0%) from Burma; 35 (0.5%) from India; 18 (0.3%) from Laos; and 335 (4.7%) from other countries. No malaria case was discovered during this survey. However, in the latter half of 1959, one *P. vivax* case each was found among students from Malaysia and Laos.

From September to December 1960 nearly 2,000 overseas Chinese came from Indonesia in five successive groups, and were granted permanent residence in Taiwan. Among blood smears collected from 1,480 of them, two *vivax* infections were revealed, the parasite rate being 0.14%, which was about seven times the rate (0.02%) for all of Taiwan during the second half of 1960.

Thousands of returnees (or Chinese refugees) from the Sino-Thai-Burmese border area moved to Taiwan between March and June 1961 (*see* "Operation Kuolei" in Chapter X). A total of 545 malaria cases (12.4%) were discovered among 4,392 returnees, including 447 *vivax*, 62 *falciparum*, 23 *malariae*, and 13 mixed infections. There were 149 (27.3%) gametocyte carriers. The parasite rate was more than 600 times that of Taiwan at the time.

In addition to the collective importation of malaria cases from the Sino-Thai-Burmese border area, there were 52 individual cases imported from all other places from July 1959 to December 1964, including two *P. ovale* infections in 1963. These 52 cases were mostly overseas Chinese frequenting Taiwan from malarious countries. Along with the international agricultural exchange program which began in March 1963, an increasing number of cases was found among African nationals.

On July 18, 1964, PHA called for a meeting of representatives of the quarantine stations and the health centers of Keelung city, Taipei city, and Kaohsiung city; the Surgeon General's Office; the Institute of Public Health (National Taiwan University); and TAMRI to discuss the most practical measures against importation of malaria from abroad. The meeting recommended that a simple questionnaire on malaria episodes, countries visited, etc. be completed by incoming passengers (except for those in transit) shortly before or upon arrival, and that quarantine stations at the ports of entry collect completed questionnaires and send them to the appropriate health centers for follow-up if necessary. It was also decided that the priority of follow-up visits be given to the passengers coming from malarious parts of Africa, Southeast Asia, China and the Western Pacific.

The recommendations were immediately put into practice. Overseas Chinese and returning nationals from malarious countries, especially those with a history of malaria or suggestive symptoms, were to be followed up monthly during the first year of stay and quarterly in the second and third years.

Supplementary information on overseas Chinese students, refugees from China, nationals returning from official visits (agricultural experts, engineers, etc. on exchange programs), and fishermen returning from pelagic fishing was regularly solicited from the related government agencies such as the Overseas Chinese Affairs Commission, the Ministry of Education and the Ministry of Foreign Affairs.

## ACCOMPLISHMENTS OF MALARIA SURVEILLANCE

The full-scale stratified malaria surveillance, from July 1958 to December 1964, examined 5,317,920 blood smears, revealing 1,023 positives. It uncovered 13 more transmission foci and eliminated all 18 existing ones. The last indigenous cases of malaria before the certification of malaria eradication in December 1964 were as follows: (a) the last indigenous *P. falciparum* infection occurred on July 22, 1961 at the Tungho focus in Taitung county; (b) the last indigenous *P. vivax* infection occurred on December 24, 1961 at the Wufeng focus in Taichung county; and (c) the last indigenous *P. malariae* infection occurred on November 11, 1962 at the Fengpin focus in Hualien county. The major accomplishments of the surveillance activities during the period July 1958 - December 1964 are summarized in Table 41.



**Table 41**  
*Annual Summaries of Full-Scale Stratified Malaria Surveillance (July 1958 - December 1964)*

	FY 1959	FY 1960	FY 1961	FY 1962	FY 1963	FY 1964	July-Dec. '64
<b>Population</b>	10,039,000	10,431,000	10,792,000	11,149,000	11,512,000	11,884,000	12,000,000
Number of smears examined ABER (%)	808,036 8.0	763,909 7.3	584,583 5.4	1,008,266 9.0	621,887 5.4	1,036,871 8.8	494,368 4.1
Number of positives found SPR (%)	609 0.075	122 0.016	92 0.016	100 0.010	44 0.007	35 0.003	21 0.004
Number of cases identified: By species <i>P. falciparum</i> <i>P. vivax</i> <i>P. malariae</i> <i>P. ovale</i> Mixed infection	461 91 259 95 0 16	105 2 69 34 0 0	84* 15 40 27 0 2	98 13 35 50 0 0	40 1 20 19 0 0	35 11 7 15 2 0	21 0 15 6 0 0
By source of infection Indigenous Relapsing Induced Imported Introduced Cryptic Congenital Uninvestigated	388 27 0 0 0 0 0 46	77 13 9 5 0 0 0 1	15 31 12 8 15 0 2 1	57 23 7 9 0 2 0 0	5 15 1 9 9 1 0 0	0 8 5 20 0 0 2 0	0 3 3 1 13 1 0 0
Transmission foci carried over from previous year newly-found eliminated	5 4 6	3 1 1	3 2 4	1 3 2	2 2 3	1 0 1	0 1 1

ABER = Annual Blood Examination Rate; SPR = Smear Positivity Rate.  
 \* Excluding 545 cases among 4,392 refugees from the Sino-Thai-Burmese border area.

A three-member WHO evaluation team which visited Taiwan from November 19 to December 18, 1964 examined the accumulated malaria surveillance records (epidemiological, entomological and operational), verified the classification of malaria cases, investigated the laboratory practices, made field observations at some old transmission foci, and inspected the malaria surveillance activities being carried out by some health center and health station personnel. The team recommended that Taiwan be included in the WHO register of countries where malaria eradication had been achieved. An official WHO Certificate of Registration (reprinted on page 181 in reduced size) was presented on December 4, 1965 by Dr. Milton P. Siegel, Assistant Director General of WHO, to Mr. Chen-Tung Lien, Minister of the Interior, Republic of China.

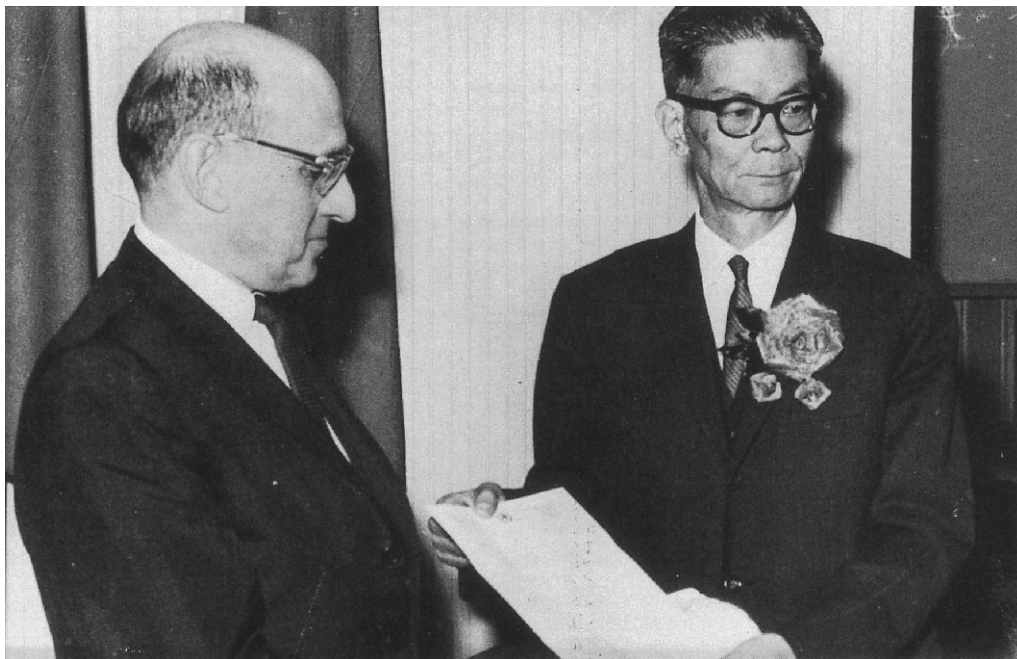


Fig. 73: Dr. Siegel presenting the WHO Certificate of Registration to Mr. Lien on December 4, 1965

WORLD HEALTH  
ORGANIZATION

Office of the Director-General  
Bureau du Directeur Général



ORGANISATION MONDIALE  
DE LA SANTÉ

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Tel.: 33 10 00 - 33 20 00 - 33 40 00

Ref: M2/180/11  
M2/372/3 CHINA

Geneva, 25 November 1965

Sir,

I have the honour to inform you that, based on the Report submitted to me by the Director of the WHO Regional Office for the Western Pacific and following his recommendation, the name of China (Taiwan) was entered on 1 November 1965 in the WHO Register of areas where malaria has been eradicated.

The status of malaria eradication in the area that has been entered in the WHO Register will be published every semester in the Weekly Epidemiological Record of WHO based on your quarterly reports to the WHO Regional Office for the Western Pacific regarding the malaria status of the area.

I wish to take this opportunity to express my deep satisfaction and congratulations to you, the Staff of the Malaria Service and the Health Services for this great achievement.

I have the honour to be,

Sir,

Your obedient Servant,

Sgd./M. G. Condaou

M. G. Condaou, M.D.  
Director-General

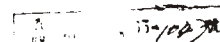
The Director  
Department of Health Administration  
Ministry of Interior  
Taipei  
Taiwan  
Republic of China

cc. The Minister of Foreign Affairs, Ministry of Foreign Affairs, Taipei,  
Taiwan, Republic of China

Dr T. C. Hsu, Commissioner of Health, Department of Health, Taiwan  
Provincial Government, Wufeng Hsiang, Taichung, Taiwan, Republic of  
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Dr C. T. Loo, Director, National Defence Medical Centre, 4th Section,  
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