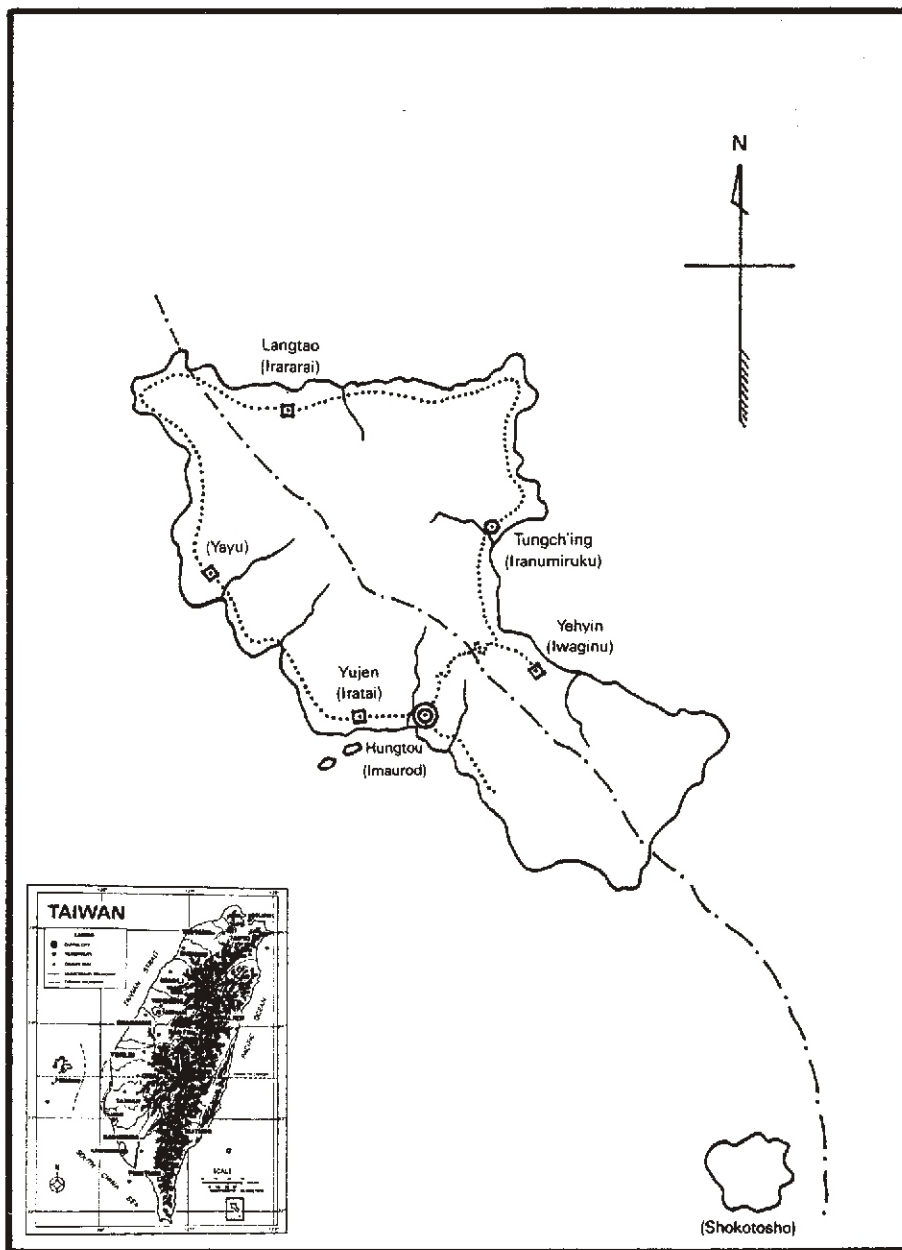


## Chapter XIV

### MALARIA ERADICATION IN LANYU



Map 17: Lanyu

## LANYU AND ITS PEOPLE

Lanyu<sup>5/</sup> is a small island township of Taitung county situated in the Pacific Ocean between 22°- 22.6° N and 121.29°- 121.36°E, approximately 65 km east of the southern tip of Taiwan proper, 80 km from Taitung city. The island is 45 km<sup>2</sup> in area, with a coast line stretching roughly 38 km. The highest mountain is 548 meters. The climate is tropical, with only two seasons - summer (April - November) and winter (December - March). The summer average is 29.6°C, with a high of 32.9°C in July; the winter average is 21.4°C, with a low of 19.2°C in January. Due to the influence of the Southeast Asian monsoons, Lanyu is frequently attacked by typhoon winds. The average annual rainfall is about 3,573 mm, with a range from 1,500 to 4,150 mm.

The aborigines on Lanyu belong to the Yami tribe (Figs. 88 and 89), one of the nine aboriginal tribes in Taiwan. However, due to their long isolation from outside influence, the Yami people have maintained their unique way of life, culture and social structure that differ greatly from those of other tribes in Taiwan proper.

One of the distinctive features of the Yami culture is the architecture of their houses. There are three types of houses - one built on stilts, used for recreation and daytime activities and for sleeping in the summer time (Fig. 90); one constructed on ground level, used as a work house or as guest quarters (Fig. 91); and one, the dwelling house, built in an excavation with only the roof above the ground for protection against the typhoon winds. This latter house is called the "winter house" (Fig. 92). The rooms are dark and poorly ventilated. Cooking is done on an open hearth inside the house, which over time covers the interior walls with a layer of heavy soot, thus interfering with the residual effects of insecticides. Apart from these three main types of houses, a temporary maternity house is often built to accommodate an expectant mother shortly before delivery (Fig. 93).

Although the Yami people live by cultivation of taro (especially wet taro), sweet potato and yam for their main staple food, fishing is the principal occupation of the men (Fig. 94), and fish provide the main source of protein. Large quantities of both fresh and dried fish (Fig. 95) are eaten, but consumption is frequently dictated by native customs, *e.g.*, some fish can be eaten by both men and women, while other fish can be eaten only by men or by women.

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<sup>5/</sup> Literally translated from Chinese as Orchid Island, Lanyu is also known as Kotosho by the Japanese and Botel Tobago by the Europeans.



Fig. 88: A young Yami couple



Fig. 89: Yami men in ceremonial dress



Fig. 90: Daytime house - a platform on stilts

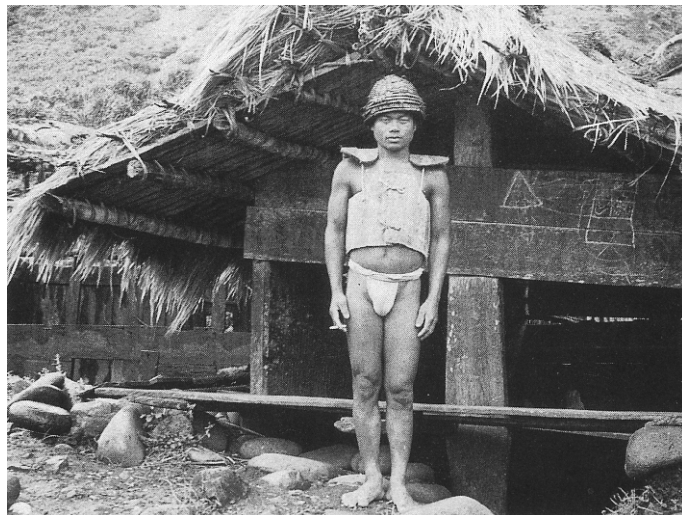


Fig. 91: Yami working house

Fig. 92:  
A typical  
Typhoon-proof  
"winter house"



Note: The Yami dwelling house is built in an excavation, with only the roof above the ground, surrounded by a stone fencing. The ceiling is low (about 4-5 feet), making it difficult to stand inside the house.



Fig. 93: A maternity house



Fig. 94: Yami men returning from a fishing trip

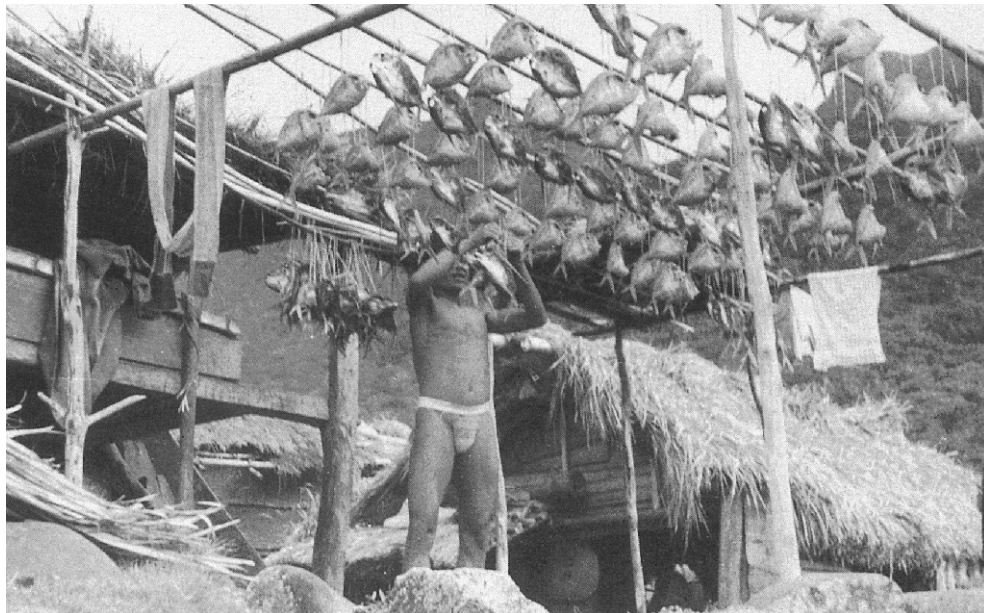


Fig. 95: A Yami man hanging fish to dry

The number of inhabitants on the island in 1906 was 1,427; for the next 50 years the population fluctuated from a low of 1,273 (1947) to a high of 1,777 (1939) (Table 55). According to a demographic study of the Yami tribe conducted by Chen K.P., Kuo and Wu (1968), the birth rate per 1,000 population for the period of 1956 - 1965 was 47.35. Assuming this is the normal birth rate of the Yami people, the slow population growth before 1965 must be attributed to a high mortality rate due to poor sanitation, poor or non-existing medical facilities, and epidemics of infectious diseases which swept the island from time to time. Bergner, Raulston, de Beauclair and Khaw (1973) reported epidemics of poliomyelitis and amoebic dysentery in 1916 and Spanish influenza in 1923, which had markedly reduced the population. Lee, Chen K.P. and Kuo (1949) reported a cholera epidemic right after World War II, which together with malaria might have killed many people on the island (the population in 1947 was 1,273, the lowest since 1906). DDT residual house spraying was initiated in 1953 and by 1954 malaria transmission was practically interrupted. Since that time the population growth has shown a linear progression.

**Table 55**  
*Population of Yami Tribe in Lanyu*

Year	Population	Source of Information	Major Events
1906	1,427	Bergner, Jr. <i>et al.</i> (1973)	Poliomyelitis and amoebic dysentery in 1916 - 1921
1929	1,619	Inaba, Segawa (1931)	
1932	1,702	Lee <i>et al.</i> (1949)	Influenza in 1923
1939	1,777	Bergner, Jr. <i>et al.</i> (1937)	
1942	1,602	Bergner, Jr. <i>et al.</i> (1937)	
1946	1,275	Bergner, Jr. <i>et al.</i> (1937)	Cholera epidemic right after World War II
1947	1,273	Lee <i>et al.</i> (1949)	
1953	1,368	TAMRI	Malaria eradication program initiated in 1953
1956	1,550	Bergner, Jr. <i>et al.</i> (1973)	
1957	1,642	TAMRI	Malaria eradication achieved
1965	2,048	Chen K.P. <i>et al.</i> (1968)	
1989	3,016	National Dept. of Health	

## ANTIMALARIA ACTIVITIES

Although there has been no information available to indicate when and how malaria first arrived in Lanyu, it is reasonable to assume that the disease was brought to the island by the first Yami settlers from the Batan archipelago, believed to be the origin of the Yami people. The first report available on malaria in Lanyu was by Miyahara (malariologist) who visited the island in 1937 with Omori (entomologist). Miyahara conducted a malariometric survey in Lanyu, examining 958 persons of all age groups for spleen enlargement and malaria parasites. Of the 958 individuals, he



found 643 with enlarged spleen (spleen rate - 67.1%). The spleen rate was highest (94%) among the age group 0-5 years old, gradually declining to 42% among those 46 years old and above. There were 153 persons with malaria parasites, giving a parasite rate of 16%, ranging from 63% for the 0-5 year old group to 8% for those 46 years old and above. It was noted that *P. malariae* represented 35% of all infections. As a member of the same survey team, Omori identified three species of anophelines on the island, *i.e.*, *An. sinensis*, *An. minimus* and *An. maculatus* (only one larva of the latter).

Lee, Chen K.P. and Kuo (1949) of the Department of Hygiene and Public Health at the Medical College of the National Taiwan University visited Lanyu in 1947 and conducted a malariometric survey, taking samples from all six villages on the island. Of the 408 persons examined for spleen enlargement, 307 had a palpable spleen, giving a spleen rate of 75.2%. Again, the spleen rate was highest (100%) among those in the 0-5 year old group, gradually declining to 45.4% among those between 46-50 years old. In the blood examinations, 25 persons (6.1%) were found to be positive for malaria parasites. Again, the age group 0-5 years old showed the highest parasite rate (25%). Of the 25 positives, *P. vivax* accounted for 24 and *P. falciparum* for one. In the anopheline survey, only *An. sinensis* and *An. minimus* were found.

A malariometric survey was initiated in April 1953 by the first TAMRI team to visit Lanyu, but was not completed until June 1953 by the second TAMRI team. Of the 682 inhabitants examined, the spleen rate was 97.51%, the average enlarged spleen (AES) was 2.99, and the parasite rate was 14.14%. The spleen rates were high among all age groups, ranging from 95.18% to 100%. The parasite rates, however, showed great differences among age groups, from 59.38% for the age group 2-4 years old and declining gradually to 8.57% for the group of 30 year-olds and above. This condition could be classified as "holoendemic." Considering the holoendemic malaria situation and the unfavorable housing conditions, it was decided to apply 2 gm of technical grade DDT per m<sup>2</sup> of surface every six months. Lanyu was the only place in Taiwan where DDT was sprayed twice a year. The DDT spraying operations were initiated in June 1953 and henceforth repeated every six months through 1955, ending with one final application in 1956. During the last spraying cycle (November 1956), a mass treatment using chloroquine (12 mg base/kg body weight) was given to the entire population.

Fig. 96:

Spraying the inside of a "winter house" is a difficult job, even for a local sprayman



Fig. 97: Yami men unloading DDT from their boat



Fig. 98: Spleen examination, Lanyu

Despite difficulties in obtaining sea passage to visit the island, TAMRI made special efforts to send its field supervisors and survey teams once every six months during the period 1953 - 1955 and once a year in the subsequent years until 1964. The initial malariometric and entomological surveys made in June 1953 provided baseline data for evaluation of the effectiveness of DDT sprayings. Having a high malaria endemicity and being isolated from the outside world, Lanyu was an ideal place to demonstrate the efficacy of DDT spraying, although it was not initially planned to play that role. The decline of malaria indices following DDT sprayings is summarized in Table 56.

**Table 56**  
*Malariometric Surveys in Lanyu*  
*April 1953 - April 1960*

Date of Survey	Total Exam.	Spleen Rate	AES	Parasite Positive					Para. Rate %
				<i>Pv</i>	<i>Pf</i>	<i>Pm</i>	Mix	Total	
April - June 1953	682	97.51	2.99	32	45	15	4	96	14.08
December 1953	461	79.18	2.66	22	31	24	4	81	17.57
June 1954	704	83.52	2.27	29	31	34	4	98	13.92
May 1955	1,433	N/A	N/A	25	5	26	3	59	4.12
November 1955*	1,502	N/A	N/A	7	3	32	2	44	2.93
December 1955**	1,537	N/A	N/A	5	0	7	0	12	0.78
April - May 1957	1,642	N/A	N/A	0	0	1	0	1	0.06
April 1960	2,371	N/A	N/A	0	0	0	0	0	0.00

AES = Average enlarged spleen

N/A = Data not available

\* = Before mass treatment with chloroquine

\*\* = After mass treatment with chloroquine

As shown in the above table, the people examined in the first three surveys were only a portion of the entire population on the island, while in the subsequent surveys all the island inhabitants were examined. Furthermore, in a given age group, the samples taken in each survey were different in proportion to the population of that age group. Since there were differences in parasite indices among the age groups, these disproportionate samples could result in a certain bias when compared with subsequent surveys which dealt with the entire population. To make the parasite rates more compatible, the rates of the first three surveys are weighted according to the natural distribution of the population, as shown in Table 57.

**Table 57**  
*Number of People Examined According to  
 Age Groups in the First Three Surveys in Lanyu*

Age Group (yrs)	April - June 1953			December 1953			June 1954		
	Reg. Pop.	No. Exam.	Para. Rate %	Est. Pop.	No. Exam.	Para. Rate %	Est. Pop.	No. Exam.	Para. Rate %
2-4	140	32	59.4	141	99	51.5	143	104	48.1
5-9	175	123	21.1	177	74	25.7	179	173	22.0
10-19	197	133	12.0	199	88	6.8	201	159	2.5
20-29	299	149	8.1	302	72	2.8	306	104	1.9
30+	557	245	8.6	563	128	2.3	569	164	2.4
Total	1,368	682	14.08	1,382	461	17.57	1,398	704	13.92

Para. Rate = Parasite rate obtained in the survey.  
 Reg. Pop. = Population registered.  
 Est. Pop. = Estimated population

From the data given in the above table, the weighted parasite rates for the first three surveys were calculated; namely, 15.78% for the April-June 1953 survey; 11.07% for the December 1953 survey; and 9.59% for the June 1954 survey. DDT was sprayed for the first time in June 1953, and therefore the first parasite survey in April-June 1953 was the baseline for the evaluation of the Lanyu program. In 12 months, the parasite rate was down from 15.78% to 9.59%; in 24 months it declined further to 4.12%; and in 30 months to 2.93%. Compared with the results obtained in the Chishan pilot project area, the decline in the parasite rates in Lanyu seemed to be somewhat slower, but this could be due to the fact that the malaria endemicity in Lanyu had been much higher and *P. malariae* infections were more numerous. If only *P. falciparum* infections were taken into consideration, the response of the parasite rate was in line with an early complete interruption of malaria transmission (Tenth Report, WHO Expert Committee, 1964).

During the third survey in June 1954 (12 months after the initial DDT spraying), 55 infants were examined. Of these, three were found to be infected with malaria parasites - two of them with *P. malariae* and one with *P. falciparum*. Two of

the three infected infants seemed to be older than 12 months and therefore could have been infected before DDT had taken effect. The third infant was infected with *P. malariae* and was born two to four months before the examination; therefore, this infant may well have been a new infection, although the possibility of congenital infection could not be completely ruled out.

There was a health station on the island, with a malaria technician and a midwife on duty, where sick people were treated. Because of the distances, people from four of the six villages on the island had not been utilizing this health facility. The data given in Table 58 are from those out-patients coming from the two closest villages. According to the malaria technician, only about one half of the malaria cases had been confirmed by microscopic examination, and the rest by clinical symptoms.

**Table 58**  
*Malaria Out-Patients at the Lanyu Health Station*

Period	Total No. of Out-patients	Malaria Patients	Percentage of Malaria Patients
July - Dec. 1951	552	238	43.12
Jan. - June 1952	783	201	25.67
July - Dec. 1952	536	159	29.66
Jan. - June 1953	876	199	22.72
----- DDT Spray -----			
July - Dec. 1953	146	21	14.38
Jan. - June 1954	317	9	2.84

A single dose of chloroquine (12 mg base/kg body weight) was distributed in November 1955 to the entire population, except infants. Apparently, this mass treatment helped to lower the parasite rate, even though it was not enough to clear up all residual infections.

In entomological surveys made in April and again in June 1953 prior to the initial application of DDT, both *An. minimus* and *An. sinensis* were found resting

inside native houses. Entomological surveys were subsequently repeated every six months through 1955, and then once per year through 1964, by a TAMRI entomological team. *An. minimus* were never found after the June 1953 survey by TAMRI personnel. Lien *et al.* (1974) also reported that they had never found *An. minimus* since the malaria eradication program was initiated. Entomologists of the National Institute of Preventive Medicine (former TAMRI entomologists) visited Lanyu in 1982, 1985, 1987, and most recently in September 1990. No *An. minimus* were found, using light trap collections and dipping for larvae, although some *An. sinensis* and *An. maculatus* were found.

#### OBSERVATIONS OF BEDBUGS IN LANYU

During the initial visit by antimalaria personnel to Lanyu (April 1953), TAMRI team members spent part of their first night collecting more than 20 tropical bedbugs (*Cimex hemipterus*) from benches being used as beds. No formal bedbug survey was begun, but specimens could be collected in any of the semi-subterranean (winter) houses in which they were sought. When the second TAMRI team went to Lanyu two months later, entomology personnel made a bedbug survey before the "winter," "working," or "maternity" houses received their first spraying with 5% water-dispersible DDT suspension. The extent of and the results from that and subsequent surveys are shown in Table 59.

**Table 59**  
*Results of Bedbug Surveys*

Date	Structures Examined	Results (Number of Houses Positive)	DDT Spraying After Survey
June 1953	61 "Winter" houses (before 1st spraying)	60	1st spraying
Dec. 1953	50 of above houses, which were sprayed in June 1953	0	resprayed
June 1954	"winter" houses (number not recorded)	0	resprayed
Dec. 1954	81 "winter" houses 64 "work" houses	0 0	resprayed resprayed
May 1955	60 "winter" houses 55 "work" houses 2 "maternity" houses	1 (1 nymph & 5 adults)* 1 (1 nymph)* 0	resprayed resprayed resprayed
April 1956	Number of houses examined not given; 73.0% positive; then sprayed with DDT and BHC; positivity reduced to 39.7%		
April 1957	Number of houses examined not given; rate of infestation had risen again to 75.2%		

\* These were the first bedbugs found in Lanyu since June 1953 (23 months).



## HEAD LICE ON LANYU

During the initial visit to Lanyu (April 1953) by personnel from Chaochou, head lice were noted on some women in Yayu village, but no head louse survey was made. Two months later, during a second visit to the island, entomology personnel made a pre-spraying head louse survey which produced rather startling results (Fig. 99). Of 95 male children and adults, 62 were positive for eggs (nits) or lice, or both (65.3%); of 68 female children and adults, 62 were positive (91.2%). This resulted in a total of 124 positives among 163 males and females (76.1%).

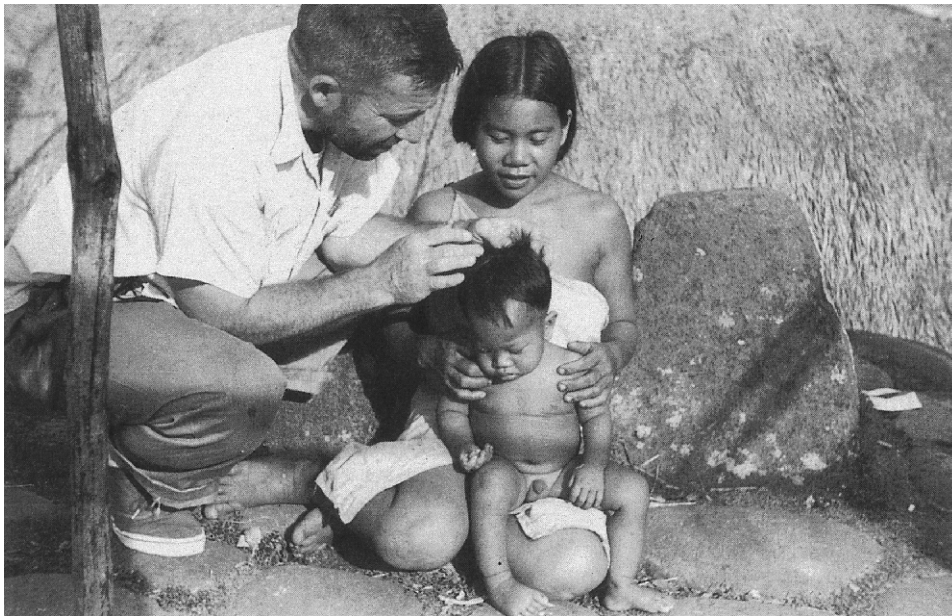


Fig. 99: Checking for head lice

Hand compression sprayers were being used to apply 5% water-dispersible DDT suspension. When the sprayers were being rinsed out at the end of each day's work, the diluted suspension (approx. 2-3%) was placed into shallow pans or basins. Many of the Yami bent over and soaked their hair briefly in the DDT rinse (Fig. 100) and then, after 10-15 minutes, rinsed their hair in fresh water. During the working visit to Lanyu six months later, two large pans were given to each village chief, and organized dunkings took place. One year after the initial trial, the survey of 164

natives yielded only three positives, and those were non-viable nits which failed to hatch after three weeks' observation. Eighteen months after the initial survey, the heads of 95 men were negative for all head louse stages. Of 67 girls and women, four had only non-viable eggs, one had nymphs only, and one had non-viable eggs and numphs or adults.

Cowan *et al.* (1947) reported the use of DDT 10% dust in many parts of the world for head louse control. The use of sprayer rinse water to relieve the Yami natives of their heavy infestations of head lice was admittedly an improvisation of the time, but had their very hearty approval.



Fig. 100: Treating head lice with insecticide