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Evaluation of Mass Treatment of Malayan Filariasis by Diethylcarbamazine in Cheju Island

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For comparison of the level of endemicity in various endemic areas of filariasis and also for the evaluation of the effectiveness of mass treatment before and after its application, various methods for the analysis of the data collected on the microfilaria surveys in a population have been taken into consideration from several view points, such as the microfilaria positive rates as well as incidence and prevalence rate, the negative conversion rates, the arithmetic mean of microfiaria counts per unit volume of blood samples, etc. It has been well known that after inauguration of a control programme, usually the parallel reductions are observed in microfilaria rates and densities. The survey of the microfilaraemia is certainly the most important and indispensable from the practical point of view in the control measure, however the microfilaria positive rates in a population represent obviously underestimates of the true due to the insensitivity of the test and the most possible various errors in the positive diagnosis.

On the other hand, the analysis on the mode of frequency distribution of microfilaria positive cases according to the microfilaria count per unit volume of blood samples has been found useful in evaluating the control programme (Sasa, 1966).

Based on our past four-year experiences of the diethylcarbamazine mass treatment applied on the malayan filariasis in a village of Cheju Island, an attempt was made in the present paper by the authors for the mathematical analysis on the dynamic change of the quantitative level of endemicity of the disease for the evaluation of the effectiveness of mass treatment in the above area.

MATERIALS AND METHODS

Geographical position of study area: The selection of areas to be surveyed was made on the basis of the previous informations already obtained, such as the existence of the active transmission of the disease, the necessity of the application of the control measure and the amenability of the people in that area.

A small representative rural village; Wimi-1-Ri, Nam Won Myon, South Cheju Goon

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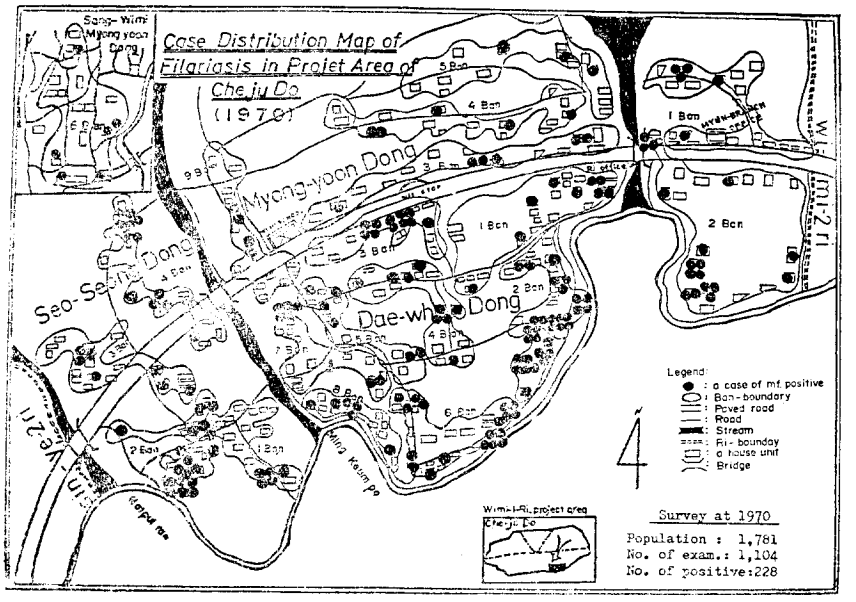

Fig. 1. Case Distribution in Wimi-1-Ri (1970).

(county), Cheju Do, previously known highly endemic area of malayan filariasis was selected as a project area for the present pilot study, in which the mass treatment has never been performed before. Administratively the island is divided into a city and two Goons (South and North Goon) in which 14 Myons are included. The project area, Wimi-1-Ri is located in Namwon Myon, east of Seogyi Eup, South Cheju Goon. The census of 1968 placed the population of this village at 1,864 among about 363,000 of whole population in the Island. Wimi-1-Ri is consisted of three Dongs (hamlet unit); Daewha, Seoseong and Myongyoon, these hamlets are grouped again with a certain number of Ban (family group unit).

Blood collection: In order to detect the microfilaria positive cases to be subjected to a selective mass treatment, a night blood survey was carried out in the entire population in the project area. The blood collections in the pretreatment survey as in the posttreatment follow-up studies were forced to make a house to house visit by the collection team because of the increased reluctance of the people. The measured blood samples for the microfilarial counts were collected with a measuring pipette from a droplet on the ear lobe in the evening after about 9 p.m. until midnight. The size in 20mm^3 was enough to make two to three stripe-smears on a slide. After the dehaemoglobinization in water and fixation in methyl alcohol, Giemsa's stain was applied for the staining of the specimens. The detection and count of microfilaria in the full film were made under low-power magnification with a combination of objectives 10× and 5×.

Schedule of mass-chemotherapy: The use of 6mg diethylcarbamazine citrate per kg. of body weight once daily (or divided into three doses a day) at monthly intervals for 12 doses, totaling 72mg per kg. in a course has also well been known as conventional chemotherapeutic course of the mass treatment of the disease. Based on the above information, the mass treatment programme was

Table 1. Results of the first year blood survey (1970).

Age	1—9		10—19		20—29		30—39		40—49		50—59		60—		Total	
Sex	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
No. of exam.	153	140	158	186	63	72	61	74	42	63	15	31	13	33	505	599
	293		344		135		135		105		46		46		1,104	
No. of positive	19	16	36	44	24	14	12	12	11	20	5	5	4	6	111	117
	35		80		38		24		31		10		10		228	
(%) positive	12.4	11.4	22.8	23.7	38.1	19.4	19.7	16.2	26.2	31.7	33.3	16.1	30.7	18.2	22.0	19.5
	11.9		23.3		28.1		17.8		29.5		21.7		21.7		20.7	
Total mf. count	1,610	1,185	1,658	3,852	503	1,377	606	1,847	1,310	1,278	429	373	663	2,037	6,779	11,949
	2,795		5,510		1,880		2,453		2,588		802		2,700		18,728	
Av. mf. count per positive	84.7	74.1	46.1	87.5	21.0	98.4	50.5	153.9	119.1	63.9	85.8	74.6	165.8	339.5	61.0	102.2
	79.2		68.9		49.5		102.2		83.5		80.2		270		82.1	

carried out on the above-mentioned project area. Treatment with "Supatonin" (Diethylcarbamazine Citrate; Tanabe Pharmaceutical Co. Ltd., Osaka) was carried out to all of positives with a dosage of 6mg/kg body weight once daily for 6 doses and with a repeat of this course one or two months later. This schedule of mass treatment was repeated year on the microfilaria positive populations detected for four years from 1970 to 1973.

Yearly follow-up and evaluation of the results obtained: All survey data collected through the yearly follow-up for 4 years from 1970 to 1973 were analysed from the several stand points; such as the yearly transition of microfilaria positive rates, incidence and prevalence rates and the microfilaria densities in the population after the yearly application of mass chemotherapy. In order to know the tendency of the intensity of infection in the project area from the epidemiological point of view, the mathematical approach of the analysis on the frequency distribution of microfilaria positive cases according to the microfilaria density was made

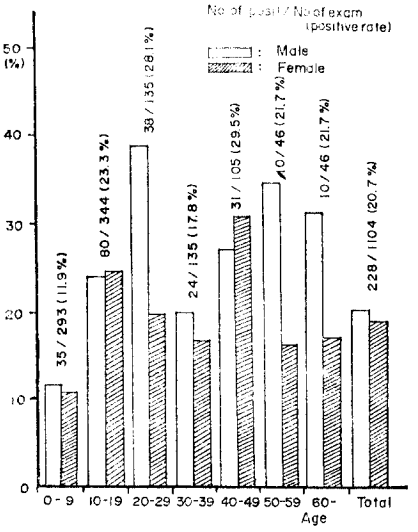

Fig. 2. Histogram showing percentage of mf. positives by age and sex (1970).

and this was also taken into consideration from the standpoint in evaluating the effectiveness of the control progamme.

RESULTS

1) The pretreatment blood survey:

The preliminary status survey was carried out prior to set up the control measure in

Table 2. Analysis based on the results of the successive two-year surveys.
Population at 1970: 1,781, 1971: 1,835, 1972: 1,869, 1973: 1,878

Year of survey / Pop. categories	1st year	2nd year	3rd year	4th year
1st survey 2nd survey	1970	1970—1971	1971—1972	1972—1973
Positive Positive		27	7	5
Positive Negative	228	118	64	26
Positive Absentee		83	20	16
Negative Positive		12	9	15
Negative Negative	876	500	619	802
Negative Absentee		364	293	310
Absentee Positive		53	32	13
Absentee Negative	677	292	471	357
Absentee Absentee		386	354	334
* Mf. positive rate to No. of exam.	20.65% (228/1,104)	9.18% (92/1,002)	3.99% (48/1,202)	2.70% (33/1,218)
** Incidence rate	—	2.34% (12/ 512)	1.43% (9/ 628)	1.84% (15/817)
*** Prevalence rate	—	15.36% (53/ 345)	6.36% (32/ 503)	3.51% (13/370)
**** Negative conversion rate	—	81.38% (118/ 145)	90.1% (64/ 71)	83.8% (26/ 31)

*: Mf. positive rates·····Positive proportion to No. of examined and to whole population at the year of survey
**: Incidence rate·····Positive proportion converted from known negatives at the successive two-year survey
***: Prevalence rate ·····Positive proportion converted from known absentees at the successive two-year survey
****: Neative conversion rate·····Negative proportion converted from known positives, treated by DEC at the year of survey

the project area at 1970. The total number of persons examined at the first year among the whole population, 1,781 were 1,104. The ratio to total population was 62.0 per cent. The number of positive microfilaria cases were 228. According to the results of the first year blood survey, the population in Wimi-1-Ri was divided into three categories: the microfilaria positives, the microfilaria negatives and the absentees (drop-outs). The microfilaria positive rates to the number examined was 20.7 per cent. And the proportions of the known negatives and absentees in the population were 49.2 and 38.0 per cent respectively. The total number of microfilariae of 228 positives was calculated as 18,728 with average 82.1 per $20mm^3$ per positive. The rates in males and females were 22.0 and 19.5 per cent respectively. And the age prevalence data was also tabulated and was shown in histogram by age and sex. However, these will be analysed from some other mathematical point of view separately later in other paper. (Fig. 1, 2, and Table 1)

2) The annual changes in rates of microfilaria positives, incidence and prevalence, and negative conversion:

Based on the successive two-year survey, there are nine combinations of the three categories of the population, classified by the results of blood survey, such as microfi-

Table 3. Results of the successive three-year survey (1972).

3rd year positive					3rd year negative					3rd year absentee				
Surver at 1st. yr.	2nd. yr.	3rd. yr.	No. of observed	Ratio to pop.	Survey at 1st. yr.	2nd. yr.	3rd. yr.	No. of observed	Ratio to pop.	Suyvey at 1st. yr.	2nd. yr.	3rd. yr.	No. of observed	Ratio to pop.
+	+	+	3	0.16	+	+	−	19	1.02	+	+	A	4	0.21
+	−	+	4	0.21	+	−	−	92	4.92	+	−	A	32	1.71
+	A	+	7	0.38	+	A	−	23	1.23	+	A	A	35	1.87
−	+	+	0	0	−	+	−	11	0.59	−	+	A	3	0.16
−	−	+	1	0.05	−	−	−	378	20.22	−	−	A	137	7.33
−	A	+	2	0.11	−	A	−	169	9.04	−	A	A	157	8.40
A	+	+	4	0.21	A	+	−	34	1.82	A	+	A	13	0.70
A	−	+	4	0.21	A	−	−	149	7.97	A	−	A	124	6.63
A	A	+	23	1.23	A	A	−	279	14.93	A	A	A	162	8.67
Total			48	2.57				1,154	61.74				667	35.69
Population of surveyed area													1,869	

* +: Mf. positive, −: Mf. negative, A: absentee in the survey

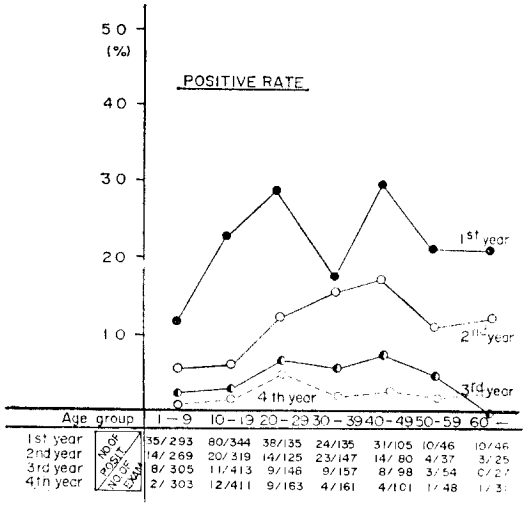

Fig. 3. Fluctuation showing the positive rates of mf. infection by age.

laria positive, negative and absentee.

The microfilaria positive rate describes the proportion of positives to the number of examined and to a population in the area at the given period. As shown in Table 2, the microfilaria positive rates to the examined at the successive four-year surveys from 1970 to 1973 were remarkably decreased, reaching 2.70 per cent from 20.65 per cent at the first year of survey (Fig. 3).

For avoiding overlapping concepts, authors defined the term of incidence rate as proportion of positives converted from known negatives at the successive two-year surveys. And they also defined the term of prevalence rate as proportion of positives detected from known absentees not treated by diethylcarbamazine at the successive two-year surveys.

In the above sense of incidence and prevalence rates, the results were analysed and shown in Table 2. The annual decreased of the incidence as well as prevalence rates were distinctly indicated from 2.34 per cent to 1.84 per cent in case of the incidence rate and from 15.36 per cent to 3.51 per cent in case of the prevalence rate.

Negative conversion rate means the proportion of negatives converted from known positives to the total number of treated at

Table 4. Summarized data throughout the four-year blood surveys (1970-1973).

Year	Population	No. of exam.	No. of mf. positives(%)	No. of negatives	No. of absentee	Total No. of microfilariae	Average(20mm³) microfilariae
1970	1,781	1,104(62.0)**	228(20.7)*	876(49.2)**	677(38.0)**	18,728	82.1
1971	1,835	1,002(54.6)	92(9.2)	910(49.6)	833(45.4)	2,531	27.5
1972	1,869	1,202(64.3)	48(4.0)	1,154(61.7)	667(35.7)	2,012	41.9
1973	1,878	1,218(64.9)	33(2.7)	1,185(63.1)	660(35.1)	1,217	36.9

Positive throughout the four-year surveys: 0 (0)**
Negative throughout the four-year surveys: 303 (16.1)
Absentee throughout the four-year surveys: 181 (9.6)
**: Number in bracket means the ratio to population
*: Number in bracket means the positive rate to the No. of examined

the previous year of survey. As indicated also in Table 2, the annual negative conversion rates were 81.38 per cent at 1971, 90.14 per cent at 1972, 83.87 per cent at 1973.

Some persistent microfilaremia cases at the two-year survey were also seen at every year of survey with decreasing number. There were also some cases of recurrent microfilaremia seen every year at the successive two-year observation.

3) Analysis on the successive three-year survey and on the summarized four year data:

Twenty-seven combinations of microfilaria positives, negatives and absentees in the successive three year surveys were analysed at the year of survey, 1972. As indicated in Table 3, the positives, negatives and absentees throughout three-year surveys were 3 (0.16%), 378 (20.22%) and 162 (8.67%) respectively. Four cases (0.21%) of apparent recurrent microfilaremia were revealed from the above results.

All data collected during the period of the four-year observations were summarized in Table 4. According to the summarized results, it turned out that the total number of the above mentioned three categories (ratio to the population) throughout the four year surveys were 0(0%) in positives, 303(16.1%) in negatives and 181 (9.6%) in absentees. The annual decrease of the microfilaria positive rates was distinct, while the microfilaria negative rates were increased. Number of absentees was almost same throughout four years except the increased figure at 1971, just a year after the drug administration. This was caused by temporary reluctance to take drugs because of their adverse reactions.

4) Quantitative analysis on the microfilaria counts:

In addition to the yearly changes of microfilaria positive rates, incidence and prevalence rates, it is essential to collect the quantitative results of microfilaria surveys based on examination of measured blood samples. In other word, the density of microfilaremia in a population has also been used as an indicater of the intensity of infection in a community. Apparently it is true that the results shown in Fig. 4 and 5 indicated the distinct decrease in terms of average and total microfilaria counts by age and sex. As shown in Table 4, the average microfilaria densities of the positives detected during the four blood surveys, whatever they were from negatives or absentees at the previous

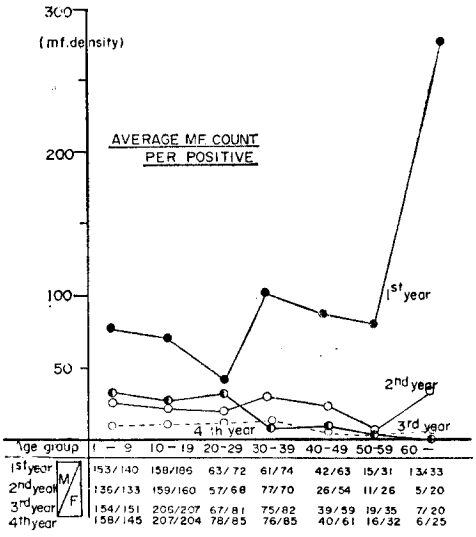

Fig. 4. Fluctuation showing the average mf. count per positive by age.

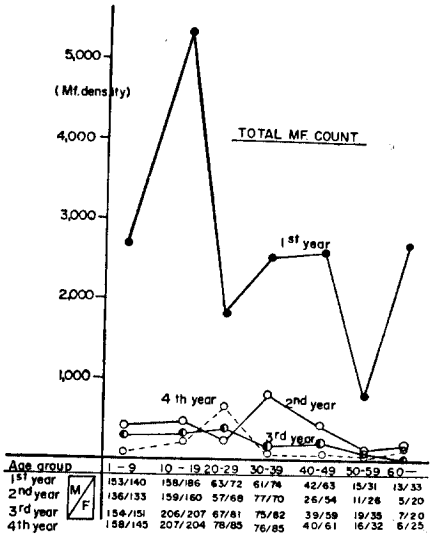

Fig. 5. Fluctuation showing the total mf. count by age.

year, have been decreased from 82.1 (Mf. range: 1 min.-1,588 max.) at the first year to 39.6 per 20mm^3 of blood at the last year.

However, from these results it must be careful immediately to draw any conclusion, even when the statistical significance is noted. Because of their skewed distribution, the simple average microfilaria counts are hardly utilized for the comparison of the level of intensity of infection without special consideration.

A mathematical approach to solve this problem was attempted by Sasa, Hayashi et al. (1959) and Sasa and Mitsui (1964). From their studies, it has been indicated that apparently there is a simple rule governing the frequency distribution of microfilaria counts in a population. And finally it was concluded that the regression line of the probit values of cumulative percentages of the positives was almost linear against logarithms of microfilaria densities, in other words, the frequency distribution of microfilaria positive cases in a population is roughly logarithmic normal. And the following equation was found to fit fairly well the data accumulated from the project area of Wimi-1-Ri, Cheju Island.

The equation is;

$$Y = a + b \log X, \text{ where}$$

"Y" is the probit of cumulative percentage of microfilaria positive cases at the level "X" microfilaria density, "X" is the number of microfilariae per unit volume of blood samples, "a" and "b" are the constants. "a" is a constant for each population, it is the probit of percentage of people with 1 (or zero in logarithm) microfilaria in the blood sample, and "b" is the regression coefficient that determines the angle of the line plotted against the horizontal axis. The frequency distribution by the microfilarial counts was calculated as well as their cumulative percentages to the total number of positive cases, as shown in Table 5.

The probit transformation of cumulative percentage distribution was made from Bliss table. The regression line for the first year

Table 5. Frequency distribution and cumulative percentages of microfilaria positive cases (1970-1973).

Year of survey	1970		1971		1972		1973	
No. of examined.	1,104		1,002		1,202		1,218	
% to population.	62.0		54.6		64.3		64.9	
No. of positive.	228		92		48		33	
% positive.	20.7		9.2		4.0		2.7	
constant"a"	3.30		3.82		3.83		3.88	
constant"b"	1.34		1.39		1.41		1.41	
Mf. D_{50}	18.57		7.06		4.00		3.80	
Mf. count per 20 cu. mm	freq.	cum. %	freq.	cum. %	freq.	cum. %	freq.	cum. %
1	13	5.70	17	18.48	12	25.00	5	15.15
2	17	13.16	7	26.09	4	33.33	4	27.27
3	13	18.86	4	30.44	2	37.50	2	33.33
4	9	22.81	6	36.96	6	50.00	3	42.42
5	3	24.13	4	41.31	1	52.08	2	48.48
6	7	27.20	3	44.57	1	54.17		
7	8	30.71	6	51.09	2	58.33		
8	4	32.46	2	53.26	0		1	51.51
9	3	33.78	3	56.52	1	60.42	1	54.54
10	8	37.29	2	58.69	2	64.58		
11—20	24	47.82	6	65.21	2	68.75	4	66.66
21—30	19	56.15	9	74.99	1	70.83	4	78.78
31—40	11	60.97	7	82.60	3	77.08		
41—50	13	66.67	3	85.86	2	81.25	1	81.81
51—60	10	71.06	3	89.12	3	87.50	1	84.84
61—70	5	73.25	2	91.29	2	91.66		
71—80	4	75.00	0	91.29				
81—90	5	77.19	2	93.46	1	93.75		
91—100	3	78.51	0	93.46				
101—200	23	88.60	4	97.81	2	97.92	3	93.93
201—300	12	93.86	1	98.90			2	100.00
301—400	3	95.18	1	100.00				
401—500	3	96.50						
501—600	3	97.82						
601—700	1	98.26						
701—800	2	99.14						
801—900	0	99.14						
901—1,000	1	99.58			1	100.00		
1,001—	1	100.00						
Total	228		92		48		33	

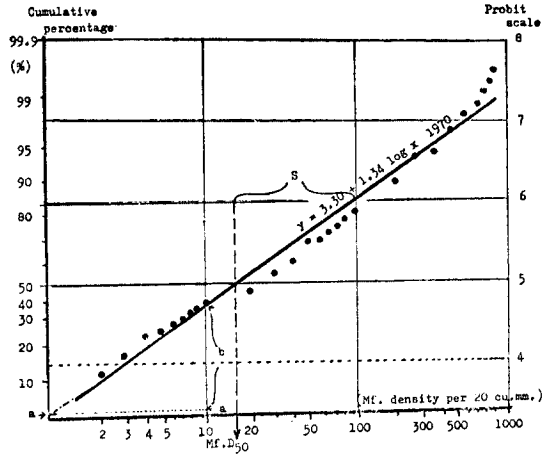

Fig. 6. Regression line of cumulative percentage of microfilaria positive cases against microfilaria density in log-probit scale (Che ju Island, Wimi-1-Ri, 1970 Survey)

of 1970 was drawn by plotting the probit value against each microfilaria counts on semilogarithmic section paper as drawn in Fig. 6. The equation was represented as it follows year by year after treatment:

$$Y=3.30+1.34 \log X \quad (1970),$$
$$Y=3.82+1.39 \log X \quad (1971),$$
$$Y=3.83+1.41 \log X \quad (1972),$$
and $$Y=3.88+1.41 \log X \quad (1973).$$

Fifty percent level of microfilaria density in this population ($Mf.D_{50}$) was obtained by solving the equation; $\log X = (5-a)/b$. The values of $Mf.D_{50}$ were 18.57 (1970), 7.06 (1971), 4.00 (1972), and 3.80(1973).

Based on the results collected year by year for successive four years after annual application of the mass treatment to the positives, the annual comparison of frequency distribution of microfilaria density was made by the value of "a", "b" and $Mf.D_{50}$, obtained by drawing the four regression lines of 1970,

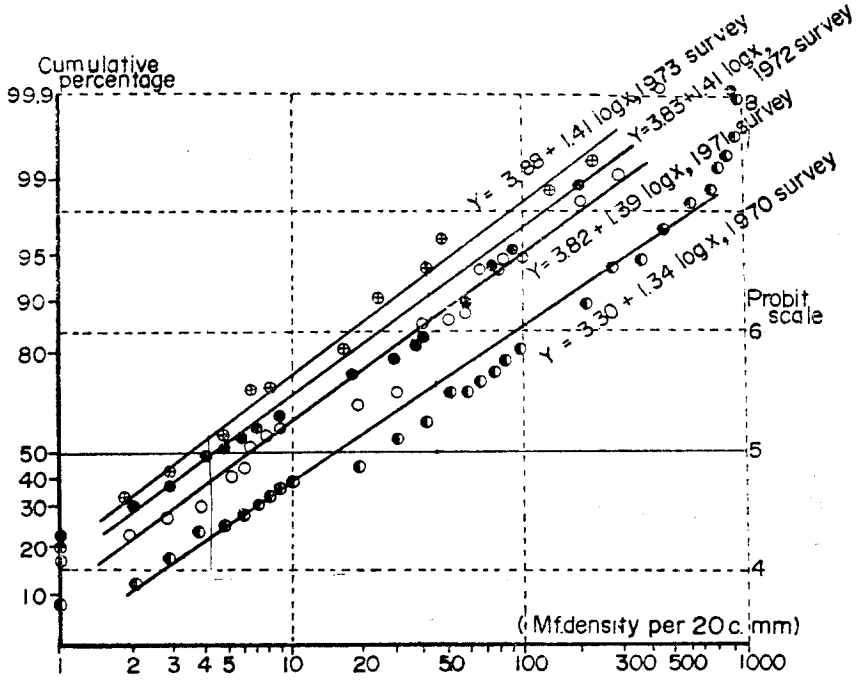

Fig. 7. Regression lines showing cumulative percentages of mf. positive cases by mf. density for four years project area, Wimi-1-Ri, Che ju Do.

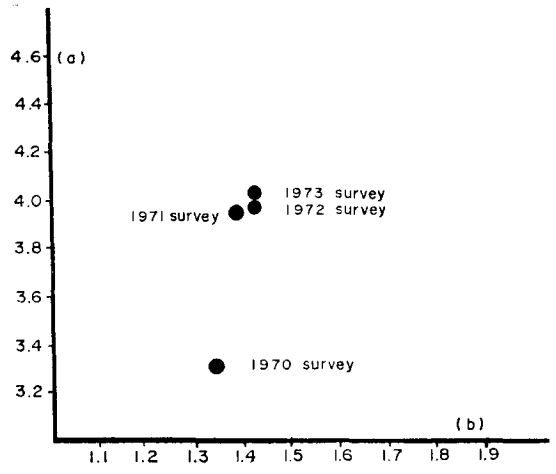

Fig. 8. Changing values of "a" and "b" of the regression equations, $Y=a+b \log X$, by the successive four year surveys (1970-1973).

1971, 1972 and 1973, as shown in Fig. 7 and Fig. 8.

From these values, it has been pointed out that the annual upward transition of the positions and angles of regression lines were clearly indicated, in other words, the effectiveness of the chemotherpeutic control measure was revealed by increasing values of "a" and "b" from 3.30 to 3.88 and from 1.34 to 1.41 respectively, and also by indicating the lowering endemicity year by year with decreasing values of Mf. D_{50} from 18.57 to 3.80 since 1970.

DISCUSSION

In this paper, quantitative measure was attempted for the assessment of the results of diethylcarbamazine mass treatment of malayan filariasis obtained from the project area of Wimi-1-Ri, Cheju Do since 1970.

Kessel et al. (1957) suggested that the average microfilaria counts per positive person or per population may be used as indicator of the effectiveness evaluation of mass treatment in Tahiti. After application of diethylcarbamazine, it was obviously osberved that the parallel reduction of the microfilaria positive rates and the microfilaria density occurred in the same population as compared with the levels before treatment. However, the extremely skewed distribution of microfilaria counts in a population may lead the average counts into wide range of variation. Therefore, it is often meaningless to make any immediate conclusion just from a simple comparison of averages, as pointed out by Jachowsky (1964).

So far the present diagnostic methods for the detection of microfilaria cases are never able to rule out completely the false negative, the microfilaria positive rates are apt to be undercalculated, especially in the area of low microfilaria density, while incidence rates show slight overestimation. Particularly, in the area where the epidemiological equilibrium was broken by administration of drugs to microfilaria cases, the microfilaria positive, incidence and prevalence data should be carefully dealt as criteria of an effective control measure.

Mahoney et Kessel(1971) analysed the data collected at the Samoan pilot filariasis control programme using incidence instead of prevalence statistics. And they pointed out that the so called failures clearing microfilaremia by diethylcarbamazine were caused roughly three reasons; primary failure of persistent microfilaria cases, reappearance of microfilariae after apparent successful treatment and new infection. The incidence of new infections is a useful statistic to describe the results of mass treatment by diethylcarbamazine, when the positives from persistent and recurrent cases were excluded by statistical manipulation. Incidence rate observed in the present study was estimated from known negatives converted to positives thro-

ugh the yearly blood survey. These rates year by year in the present study showed decrease. On the other hand, the prevalence rates in the authors' sense also have been decreased, especially the degree of reduction between the first year 1970 and the second year 1971 was remarkable.

It is certainly indicated that the effects of control measures have been apparent so far in the aspects of distinct reduction of microfilaria positive rates, and reduction in microfilaria density of the population. Particularly through the analysis of the mode of frequency distribution of data accumulated from the yearly observations for four years, the effectiveness of control measure has been evidently recognized, and represented by annually increased values of two parameters, "a" and "b".

SUMMARY AND CONCLUSIONS

Control programme of malayan filariasis by diethylcarbamazine was set up in village, Cheju-Island, Korea. The daily dose of 6mg per kg. of body weight for 6 days was chosen as a chemotherapeutic course only for microfilaria positives, which was repeated with an interval of one or two months.

For the evaluation of drug control programme the yearly posttreatment blood survey was carried out. The results collected from 1970 to 1973 were analysed from the various points of view, such as microfilaria positive rates, incidence as well as prevalence rates. The change of microfilaria counts was also utilized for the comparison of the intensity of infection among population in the four year blood surveys. Considering the extremely skewed distribution of average microfilaria density, the mode of frequency distribution of microfilaria density in a population was particularly taken into account for the evaluation of changing endemicity affected by diethylcarbamazine treatment.

The equation; $Y=a+b \log X$ (a, b; constants. X=microfilaria density; Y=probit scale of cumulative frequency of positives to X microfilariae) was found to fit farily well the data collected from four-year surveys before and after treatment. From these data obtained, four regression lines have been drawn by determining "a" and "b"; two parameters, which were increased year by year since inauguration of control programme.

In the present investigation, it was verified that the chemotherapeutic control measure of malayan filariasis applied in a village of Cheju-Island has been successfully carried out and the quantitative level of endemicity in this area has also been distinctly lowered within the four-year control programme.

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濟州道에 있어서의 "디에칠칼바마진"에 의한 馬來糸狀虫症에 대한 集團治療 評價

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제주도 남원면 위미리에서 마래사상충증의 "디에칠칼바마진"에 의한 집단치료 시범 계획을 세우고 1970년 이래 4년간 매년 施行한 仔虫 陽性者 化學療法 前後에 따르는 效果를 여러 觀點에서 分析하였다. 특히 仔虫陽性者의 仔虫濃度에 대한 度數分布를 數學的으로 檢討하여 集團治療의 有效性을 評價하였다.

集團治療 施行前의 疫學的 調査를 위하여 1970년 위미 1리 全人口(1,781名) 夜間檢血을 하고 被檢者 總 1,104名 중 仔虫陽性者 328名을 索出하였다. 陽性者에게는 每 體重 1kg당 "디에칠칼바마진" 6mg을 每日 6일 계속 投與하고 한달 또는 두달 후 다시 前記와 同一量을 反覆 投與하는 化學療法을 시행하였다. 每年 繼續 4個年間 全人口 夜間 檢血에 發見되는 仔虫陽性者는 每年 同一한 療法으로 治療하고 陽性者의 陰轉뿐만 아니라 每年 全 人口比 仔虫陽性率(Microfilaria positive rate), 發生率(Incidence rate=前年度 仔虫陰性者로부터의 陽轉率), 有病率(Prevalence rate= 前年度 檢査 漏落者로 부터의 陽性率)과 仔虫濃度(Microfilaria density=單位 血液內 仔虫數) 등등의 變化를 綜合檢討 하였다.

이상의 모든 변동은 일반적으로 뚜렷한 減少를 表示하였다. 仔虫陽性者의 檢査者 全人口에 대한 率은 各各 治療前 20.7%(1970년도)에서 2.7%(1973년도)로, 發生率 및 有病率은 各各 2.34 및 15.36%(1970년도)에서 1.84 및 3.51%(1973년도)로 減少하였다. 4개년을 치료후 仔虫陽性者로 殘留한 자는 없었으며 仔虫陰性者로 남았던 수는 303명 人口比 16.1%였고 檢査漏落(兵役中인자 또는 기타), 또는 不可能(幼小兒 包含) 한者는 181名 人口比 9.6%에 不過하였다.

平均 仔虫濃度의 減少도 뚜렷하였다. 이들 變動數値는 경우에 따라 效果判定에 相當한 危險性이 內包되고 있어 특히 年次的 集團治療에 따르는 糸狀虫症 流行强度의 變化를 量的으로 分析하고 集團治療의 有效性을 評價할 목적으로 仔虫陽性者의 仔虫濃度에 대한 累積 度數分布를 檢討하고 $Y=a+b \log X$ (a, b는 定數, X는 仔虫濃度, Y는 陽性者 累積百分率의 Probit 값)에 의하여 年次的 成績을 回歸方程式으로 表示 比較하고 a, b값이 增加됨을 알 수 있었다. Y의 年次的變化는 다음과 같다.

$Y=3.30+1.34 \log X$ (1970년)

$Y=3.82+1.39 \log X$ (1971년)

$Y=3.83+1.41 \log X$ (1972년)

$Y=3.88+1.41 \log X$ (1973년)

위의 成績을 綜合하건데 爲美 1里에 있어서의 Diethylcarbamazine에 의한 年次的 集團治療는 效果的으로 施行되었음을 感染 强度 變動에 對한 數學的인 分析으로 判明할 수 있었다고 할 수 있다.