

REVIEW

THE FILARIASIS SITUATION IN GUANGDONG PROVINCE, CHINA

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Abstract. This paper describes the general situation, historical perspectives, epidemiological surveys (including geographical distribution, microfilarial rate, microfilarial rate in different age groups, clinical features, animal filaria, periodicity of *Wuchereria bancrofti* and vector species), experimental research and control of filariasis in Guangdong Province, China.

INTRODUCTION

The present situation of filariasis in China was reported by Huilan *et al* (1981). They described the epidemiology, symptomatology, diagnosis, treatment, prevention and control of filariasis in China including Guangdong Province, thus providing an important document on filariasis research and control in China. We report here details on the filariasis situation in Guangdong Province.

GENERAL SITUATION

Guangdong Province is situated in the southern part of China, between 20° 18' – 25° 28' N latitude and 109° 45' – 117° 20' E longitude. There are 19 cities and 76 counties in this province. It has a population of more than 60 million and its total area is 178,000 square kilometers. The topographical feature is elevation declining from north to south. Mountainous areas are mainly formed in the northern part and northwestern part. The southern part is a zone with networks of waterways. The climate is mainly sub-tropical. The annual mean atmospheric temperature is 19°C to 24°C. July is the hottest month (28°C–29°C) and January the coldest month (9°C–21°C). The annual rainfall is more than 1,500 millimeters and over 2,000 millimeters in some areas.

HISTORICAL NOTE

Filariasis is one of the most important parasitic

diseases, affecting a large number of people. Whyte and Camb conducted a study in 1909 on the relationship between the microfilarial periodicity and eosinophilia in this province. They examined 600 persons and found 49 (8.2%) of them to be microfilaremic. Jackson (1936) reported on filarial infection in man and mosquito in Hong Kong. He found 13 out of 106 (12.26%) persons to be microfilaremic for *Wuchereria bancrofti* in 1932. During the period from 1933–1935, Jackson examined 3,733 prisoners and found 45 (1.21%) with *W. bancrofti*. In 1932 to 1935, 13 cases of filariasis were reported from all government hospitals in Hong Kong. Jackson also found filarial larvae in *Anopheles minimus*, *An. jeyporiensis candidiensis* and *Culex pipiens fatigans* in 1932. Shih-Hui *et al* (1959) examined 5,599 persons in Conghua County, about 56 kilometers northwest of Guangzhou City, where microfilariae were detected in 666 (11.9%) persons. 2,229 *Cx. pipiens fatigans* were dissected and 10.5% of them harbored filarial larvae at various developing stages. Shih-Hui *et al*, 1959a,b considered that *Cx. pipiens fatigans* to be important vector of *W. bancrofti* in that area. Shih-Hui *et al* (1959 a,b) reported that 415 microfilaremics (28.6%) were detected from 1,459 farmers. The natural filarial infection rate in *Cx. fatigans* was 7.4% (84/1,134). From these data, it can be seen that filariasis was prevalent for a long time in this province. The situation since the 1950s will be described below.

EPIDEMIOLOGICAL SURVEY ON FILARIASIS

Since 1953, investigations were carried out to determine the prevalence and distribution of filariasis, and these are reported below:

Geographical distribution

Two species of human filaria, *W. bancrofti* (Cobbold, 1877) and *Brugia malayi* (Brug, 1937) are found in this province. The former is ubiquitous but *B. malayi* is present only in Pingyuan County, in the northeastern part of this province neighboring Jiangxi Province and Fujian Province. The *B. malayi* strain is naturally periodic and its principal vectors are *An. lesteri anthropophagus* and *An. sinensis*.

W. bancrofti is widely distributed in this province; southern and eastern coastal districts and some part of the northern mountainous areas are important endemic areas while the central part of this province, the Pearl River delta and

some part of the mountains are relatively unaffected or even free of filariasis. In general, the microfilarial rate in the coastal and rural areas is higher than that in the inland and the urban areas. In the coastal district, the microfilarial rate in the plain is higher than that in the mountains, but in the northern mountainous areas, the microfilarial rate in the mountains is higher.

Microfilarial rate

Fourteen counties or cities were investigated during 1953–1957. Two thousand nine hundred fifty-six (2,956) microfilaremics were found among 39,087 persons, the mean microfilarial rate being 7.56% (Table 1).

In 1958–1960, we examined 7,194,293 persons covering 47 counties or cities, 221,331 microfilaremics were found, the microfilarial rate being 3.08%. In 1961–1969, 20,577 microfilaremics were found among 428,575 persons in 17 counties or cities surveyed, the mean

Table 1

Survey on filariasis (1953–1957).

Locality	Year	No. of exam	No. of Mf carrier	Mf rate (%)
Conghua	1965	1,961	352	17.95
Shantou	1954	5,209	426	8.18
Chaoyang	1953	973	100	10.28
Chaozhou	1956	1,655	49	2.96
Haifeng	1953	503	30	5.96
Lufeng	1954	2,136	313	14.65
Huilai	1956	327	31	9.48
Raoping	1957	628	43	6.85
Huiyang	1956	1,192	184	15.44
Huidong	1956	2,681	390	14.55
Doumen	1956	731	122	17.11
Zhanjiang	1956	16,269	791	4.86
Gaozhou	1956	3,577	47	1.31
Suixi	1957	1,263	78	6.81
Total		39,087	2,956	7.56

Table 2

Survey on filariasis (1958-1986).

Year	No. of counties or cities	No. of exam	No. of Mf carrier	Mf rate (%)
1958-1960	47	7,194,293	221,331	3.08
1961-1969	17	428,575	20,577	4.80
1970-1986	95	53,683,819	913,876	1.70

Table 3

Stratification of the basic of microfilarial rate before control.

Mf. rate (%)	No. of counties or cities		%
	<i>W. bancrofti</i>	<i>B. malayi</i>	
Below 0.99	24		36.92
1.00- 5.00	30	1	47.69
5.01-10.00	10		15.38
Total	64	1	100.00

Table 4

Microfilarial rate of different age groups in various endemic areas.

Age group	Over 10.1% area		5.1-10.0% area		Below 5.0% area	
	No. exam	% Mf	No. exam	% Mf	No. exam	% Mf
1-9	6,943	2.74	12,788	1.85	35,508	0.66
10-19	9,032	7.46	12,051	6.38	33,307	1.96
20-29	3,789	13.88	5,637	10.00	22,559	2.73
30-39	3,229	16.32	5,625	11.36	15,952	3.50
40-49	2,077	17.96	3,564	12.12	14,472	3.99
50-59	1,729	22.56	2,652	15.35	11,302	4.50
60-	2,017	23.45	3,201	14.06	12,512	4.23
Total	28,816	10.94	45,518	7.68	145,612	2.53

microfilarial rate being 4.80%. In 1970–1986, large scale filariasis surveys were carried out all over this province; 913,876 microfilaremics were found among 53,683,819 people, the mean microfilarial rate being 1.70% (Table 2).

Sixty-five counties or cities have been found to be filariasis endemic areas with different microfilarial rates. Stratification on the basis of microfilarial rates revealed that 24 counties or cities have microfilarial rates below 0.99%, 31 between 1.00% and 5.00%, 10 over 5.01% (Table 3).

Microfilarial rates in different age groups

The data accumulated from blood surveys carried out in various endemic areas in 1970–1972 showed that the older the age group, the higher the microfilarial rate. The microfilarial rate is the lowest in the age group of 1–9 and the highest in the age group of 50–59. In the age group 20–29, the microfilarial rate almost as high as the average value of the whole population (Table 4).

Children below 10 years old showing microfilarial rate of about 0.5% were in the age groups 1–2, 3–4 and 5–6 in various endemic areas where the average microfilarial rates were 10.94%, 7.80% and 2.53% respectively. In these three endemic areas, the microfilarial rate in the age group 9–10 was only approximately half the average value of the whole population (Table 5).

Clinical survey

In some endemic areas, the clinical survey of filariasis was made by inquiry and physical examination. Examination methods were not uniform and some filarial signs such as the enlarged filarial lymph nodules were difficult to differentiate from those caused by other pathogens. The main clinical manifestations of bancroftian filariasis were elephantiasis, chyluria and hydrocele, the latter being rather common in Guangdong Province. About 60,000 patients had clinical manifestation of filariasis (about 3.0% among infected persons).

Animal filaria

Systematic survey on animal filaria have not been carried out in this province. However, *Dirofilaria immitis* has been reported in dogs but its geographical distribution and infection rates have not been investigated. In 1972, some species of animals were surveyed by the Institute of Parasitic Diseases, Chinese Academy of Medical Sciences. Three hundred ninety-one *Rattus losea*, 51 *R. flavipectis*, 45 *R. norvegicus*, 12 *R. rattus hainanicus*, 17 *R. confucianus*, 1 *R. fulvescens*, 10 *Mus musculus*, 7 *Suncus murinus*, 2 *Tamias swinhoei hainanicus* and 403 chickens were examined. Microfilariae were found in 4 *R. losea* (1.02%), 1 *R. flavipectis* (1.96%) and 98 chickens (24.32%), as shown in Table 6.

Table 5
Microfilarial rate of different age group in children
below 10 years old in various endemic areas.

Age group	10.94% area		7.80% area		2.53% area	
	No. exam	% Mf	No. exam	% Mf	No. exam	% Mf
1-2	998	0.50	1,523	0.26	4,824	0.12
3-4	1,963	0.71	3,079	0.65	8,039	0.26
5-6	1,800	2.67	3,484	1.58	8,761	0.55
7-8	1,678	4.39	3,193	3.41	9,356	0.98
9-10	765	6.41	1,499	3.20	4,528	1.52

Table 6

Animal filaria in Hainan Island.

Species	No. examined	No. positive	Rate of positive (%)
<i>R. losea</i>	391	4	1.02
<i>R. flavipectus</i>	51	1	1.96
<i>R. norvegicus</i>	45	0	0.00
<i>R. rattus hainanicus</i>	12	0	0.00
<i>R. fulvescens</i>	1	0	0.00
<i>R. confucianus</i>	17	0	0.00
<i>Mus musculus</i>	10	0	0.00
<i>Tamiosus swinhoi hainanicus</i>	2	0	0.00
<i>Suncus murinus</i>	7	0	0.00
Chicken	403	98	24.32

Periodicity of *W. bancrofti*

The periodicity of *W. bancrofti* was observed in various bancroftian filariasis endemic areas including eastern, northern, central and western parts. Sixty μ l of peripheral blood was taken for the microfilaria count at 2-hour interval successively for 24 hours in 128 cases with microfilaremia. There was a total 51,392 microfilariae, 2,414 (4.70%) being in the day time (8–18 hours) and 48,978 (95.30%) in the night. Using the analysis method of Sasa (1976), the periodic index was 98.50% and the peak hour was found to be after midnight at six minutes past one o'clock. According to the results listed above we consider that bancroftian filariasis is the nocturnal periodic type in this province (as shown in Table 7).

Vector surveys1. Vector of *W. bancrofti*

In different endemic areas of Bancroftian filariasis, 733,192 *Cx. quinquefasciatus*, 2,256 *Cx. bitaeniorhynchus*, 8,738 *Cx. tritaeniorhynchus*, 29 *Cx. vagans*, 144 *Aedes albopictus*, 5,311 *An. sinensis* and 101 *Armigeres obturbans* were

dissected, their natural infection rates were 9.92%, 1.46%, 6.78%, 0%, 0%, 2.24%, and 0% respectively. Infective larvae were only found in *Cx. quinquefasciatus* and it is considered that *Cx. quinquefasciatus* was the principal vector of bancroftian filariasis (Table 8).

The observation on natural infection rate of *Cx. quinquefasciatus* was carried out for 12 months in Dianbai County before control. The *Cx. quinquefasciatus* harboring *W. bancrofti* larvae was found from January to December. But the atmospheric temperature in January, February and March is lower than other months. The natural infection rates were lower in the colder months and February was even free of infective larva (Table 9).

The prevalence of *Cx. quinquefasciatus* has been observed in Ruyuan County and Conghua County. The density peak was in May and June. The lowest density was in winter and early spring from November to February (Table 10).

2. Vector of *B. malayi*

In 1969, the vector of malayan filariasis

Table 7

Periodicity of *W. bancrofti*.

Locality	No. cases	Number of microfilariae in various periods											
		8h	10h	12h	14h	16h	18h	20h	22h	0h	2h	4h	6h
Shantou	13	2	2	2	0	8	170	547	768	900	543	386	17
Jaoping	11	69	5	2	7	10	61	478	802	757	839	944	438
Suixi	12	27	2	2	0	4	115	325	1,287	1,193	1,155	913	938
Zhanjiang	8	0	0	0	0	2	0	2	139	163	484	470	471
Dianbai	18	0	0	0	0	0	184	1,057	502	675	747	981	941
Lechang	37	539	116	134	68	63	232	1,352	2,557	2,588	2,607	2,740	1,981
Doumen	7	28	4	3	4	0	7	99	142	217	225	338	89
Haifeng	10	0	3	5	3	39	325	822	994	1,172	1,225	1,044	806
Boluo	12	21	12	8	3	6	117	872	1,681	1,509	1,541	1,633	882
Total	128	686	146	154	85	132	1,211	5,554	8,872	9,174	9,366	9,449	6,563

Table 8

Survey of mosquito vectors of *W. bancrofti*.

Species	Number of dissections	Natural infection		Infective larvae	
		No.	%	No.	%
<i>Cx. quinquefasciatus</i>	733,192	72,738	9.92	1,615	0.22
<i>Cx. bitaeniorhynchus</i>	2,256	33	1.46		
<i>Cx. tritaeniorhynchus</i>	8,738	592	6.78		
<i>Cx. vagans</i>	29	0	0.00		
<i>Ae. albopictus</i>	144	0	0.00		
<i>An. sinensis</i>	5,311	119	2.24		
<i>Armigeres obturbans</i>	101	0	0.00		

Table 9

Natural infection with *W. bancrofti* of *Cx. quinquefasciatus* in different months.

Month	Number of dissections	Natural infection		Infective larvae	
		No.	%	No.	%
January	575	42	7.30	3	0.52
February	614	59	9.61	0	0.00
March	649	87	13.41	2	0.31
April	492	90	18.29	13	2.64
May	727	117	16.09	12	1.65
June	852	92	10.80	12	1.41
July	546	56	10.26	8	1.47
August	610	54	8.85	7	1.15
September	339	34	10.03	2	0.59
October	485	60	12.37	6	1.24
November	609	67	11.00	10	1.64
December	691	47	6.80	2	0.29

was investigated in Pingyuan County, the sole malayan filariasis endemic area in this province. The natural rates were 32.35% (22/86) in *An. lesteri anthropophagus*, 12.70% (53/417) in *An.*

sinensis, 1.17% (2/170) in *Cx. quinquefasciatus* and 3.86% (9/233) in *Cx. tritaeniorhynchus* in human dwellings. Infective larvae were found in *An. lesteri anthropophagus* and *An. sinensis*.

Table 10

Prevalence of *Cx. quinquefasciatus* (No./30 minutes).

Month	Conghua County	Ruyuan County
January	2.5	0.0
February	11.3	0.0
March	23.6	2.0
April	49.1	6.5
May	52.8	61.5
June	24.6	63.5
July	24.3	46.0
August	25.1	38.0
September	36.4	16.5
October	15.8	6.5
November	6.4	3.5
December	5.5	1.0

Table 11

Mosquito vectors of malayan filariasis.

Place	Species	Number of dissection	Natural infection	
			No. pos	%
Human dwelling	<i>An. sinensis</i>	417	53	12.70
	<i>An. lesteri anthropophagus</i>	68	22	32.35
	<i>Cx. quinquefasciatus</i>	170	2	1.17
	<i>Cx. tritaeniorhynchus</i>	233	9	3.86
Cattle-pen	<i>An. sinensis</i>	706	54	7.65
	<i>Cx. tritaeniorhynchus</i>	128	0	0.00

The larvae of *B. malayi* could not develop in *Cx. quinquefasciatus* and *Cx. tritaeniorhynchus* as only first stage larvae were found in these species. Among the mosquitos caught from cattle-pen, 7.65% (54/706) of *An. sinensis* had *Brugia* larvae. *An. sinensis* not only bites man but also bites cattle. No natural infection could

be found in 128 *Cx. tritaeniorhynchus* dissected and no *An. lesteri anthropophagus* was caught in the cattle-pen (Table 11).

Since *An. lesteri anthropophagus* could be caught in human dwelling only, and as this species had a high natural infection rate with

Brugia filarial larvae, we consider it to be an important vector of *B. malayi*.

EXPERIMENTAL RESEARCH ON FILARIASIS

The relationship between microfilariae detected and blood capacity or location of blood taken

Zuoyan (1980) examined 61 cases of bancroftian and 34 cases of malayan microfilaremics to compare the microfilaremia detected from various locations of the body. The number of *W. bancrofti* microfilaria per 60 µl blood sample taken from the ear lobe and finger were 54 and 31.9 ($t=4.29$, $p<0.01$), and for *B. malayi* were 24.7 and 5.7 ($t=8.43$, $p<0.01$) respectively. These results showed that the density of the microfilariae was greater in blood from the ear lobe compared to that from the finger. Zuoyan also observed the relationship between the microfilaria detected and blood volume taken. 1,186 people were examined, 88 were detected positive by the 120 µl blood smear, but only 69 cases were detected by 60 µl blood smear. We considered that the 120 µl blood sample for examination was better in filariasis surveys.

Provocative test with DEC during day time

It is inconvenient to take blood samples in mass survey at midnight. We therefore carried out the microfilaria provocative test with DEC (diethylcarbamazine) during the day. 150 mg DEC were given and after 15 and 30 minutes, 37.3% and 72.7% were detected with microfilariae respectively. A total of 75% of the microfilaremics could be found by the two examinations. These results are similar to those reported by Yunhe *et al* (1960) and Russel *et al* (1975).

The relationship between the natural infection rate of *Cx. quinquefasciatus* and microfilarial rate of village inhabitants

Bancroftian filariasis was found to have various levels of endemicity in villages located in northern part of this province. The principal vector *Cx. quinquefasciatus* was very common and endophilic, highly anthropophilic and susceptible to *W. bancrofti* infection. Zuoyan

et al (1983a,b) carried out field observations and experimental research in 1978-1980. Mosquitos were collected from human dwelling in various villages and dissected individually. The microfilarial rate of inhabitants and the natural infection rate of vectors showed a linear positive correlation, the correlation coefficient being 0.9574 and the regression equation was $Y = 0.8614X - 0.8557$ (Table 12).

The relationship between the microfilarial density and infection rate of vectors also showed a linear positive correlation in natural infection as well as artificial infection. Even in low density microfilaremia, a few mosquito vectors could be infected. This suggests that we must also pay attention to vector control in the control of filariasis.

Periodic *W. bancrofti* artificial infection in monkeys

Periodic *W. bancrofti* were experimentally been transmitted from man to the monkey (*Macaca mulata*). The infective larvae of periodic *W. bancrofti* were obtained from laboratory-raised *Ae. togoi* and *Cx. quinquefasciatus* fed on the blood of patients from Hainan Island. 318-822 infective larvae were inoculated subcutaneously into the groin of 10 females and into the testes of 19 male rhesus monkeys. 23 animals were thymectomized and/or splenectomized and/or treated with immunosuppressants, and 6 animals were not treated and kept for control. All experimental monkeys were dissected 231-288 days after infection. Adult *W. bancrofti* were found in 5 monkeys (17.24%) and microfilariae were found in the heart and lungs blood of 2 monkeys. Microfilaria were only found in the one monkey peripheral blood before autopsy. The microfilarial densities in heart and lungs blood were 33 and 146 in 60 µl of blood respectively.

FILARIASIS CONTROL

The Filariasis Control Program was initiated in 1956. Since 1958, a large scale investigation and filariasis control were carried out in the whole province. Treating the sources of infection was chosen as a major measure. In addition, the whole population in the filariasis endemic areas

Table 12

The relationship between the natural infection rate of *Cx. quinquefasciatus* and microfilarial rate of inhabitants.

Group	Mf rate of inhabitants			Natural infection rate of vectors		
	No. exam	No. pos	%	No. dissected	No. pos	%
1	683	3	0.44	618	0	0.00
2	208	2	0.96	1,104	2	0.18
3	158	6	3.80	1,266	20	1.58
4	378	23	6.09	655	32	4.89
5	982	90	9.16	950	50	5.26
6	598	67	11.20	1,546	158	10.22

participated in the control of mosquitos including treating their breeding places, improving environmental sanitation, conducting indoor residual spraying with insecticides and using mosquito nets for individual protection. The method of treating the source of infection was as follows:

1. Diagnosis

The thick blood smear method is generally used in field work and large scale investigation. The amount of blood is important in the examination. To increase the diagnostic efficiency, 120 µl blood were taken from the ear lobe between 9 pm and 2 am Thick blood smears were made on two slides and examined by microscope after staining.

2. Treatment

(1) Treatment of patients carrying microfilariae

Repeated check-up and selective treatment were carried out in this province. The purpose was to eradicate the source of infection. All microfilareemics were treated with 2-3 or more standard courses of DEC. Total dosage for each course was 3.0-4.2 g over 3-7 consecutive days for malayan filariasis.

Diethylcarbamazine is a drug which is used to treat human filariasis. This drug is efficacious

and safe. The curative efficiency has a strong correlation with filaria species and is affected by the mode of administration. 147 cases of bancroftian microfilareemics were treated in 1974. A dosage of 12 mg per kilogram of body weight daily for 7 days was administered as a course of treatment. Two intermittent courses of treatment were given at one month intervals between each course. The efficacy was determined at the end of treatment and 11 months after treatment. The results showed that the microfilarial disappearance rates were 91.63% and 88.96% respectively. 144 cases with bancroftian microfilareemics were treated with a dosage of 20 mg per kilogram body weight daily for three days, the number of courses and the interval of treatment were the same as above. The microfilarial disappearance rates were 75.18% and 82.26% respectively.

(2) Selective treatment combined with mass administration

This measure was used in bancroftian filariasis endemic areas where the microfilarial rate was over 5%. The microfilareemics were treated with the abovementioned therapy. All inhabitants over 5 years old were administered with DEC at a total dosage of 3 g divided into 3-5 days administration.

(3) Selective treatment combined with medicated table salt

This method was carried out in the mountainous areas where the microfilarial rate was over 10%; the repeated check-up and selective treatment were carried out 1-2 times. The medicated table salt with DEC in the ratio of 0.3% (3 g DEC to 1,000 g salt) supplied to the inhabitants for their daily diets for 6 months. The daily intake of DEC approximated 50 mg and about 9 g in total within 6 months.

(4) Treatment of patients with clinical signs

Patients with elephantiasis of lower limbs were treated with dry heating and bandaging therapy. In this therapy, the affected legs were heated to a temperature of 80-90° C for 30-60 minutes each time at 3-5 days interval, repeated 20-40 times per year for several years. After heating the affected leg was bound with an elastic bandage made of cotton cloth or other suitable material in an ascending direction spirally during day time. The skin of the leg was kept dry and clean; attention was paid of prevent secondary infection and a small dosage of DEC was administered for long term if necessary. There was improvement and even cure in some cases, but the effectiveness was not ideal because elephantiasis relapsed in some patients a few months after treatment.

Surgical operation is effective for the patients with hydrocele of the tunica vaginalis and elephantiasis of the scrotum. 59 patients with hydrocele of the tunica vaginalis were surgically treated in 1971. All of these patients were cured as none of the patient relapsed in two years.

3. Recent advances on filariasis control

Large scale control of filariasis has been achieved in this province by carried out mass surveys and three kinds of DEC therapeutic regimens to eradicate the source of infection. Up to 1986, 1,307,529 microfilaremics had been cured, 4,175,785 and 2,474,506 inhabitants had been treated with mass administration and medicated table salt respectively (Table 13).

According to requirements endorsed by the Ministry of Public Health, we have established a system to examine the efficacy of control measures. The results showed that the microfilarial rates were greatly reduced. Up to December 1986, filariasis has been basically eliminated in 65 counties or cities, all the filariasis endemic areas, where the microfilarial rate is below 0.5% in the villages and the average microfilarial rate has come down to 0.12%. However, greater efforts to eradicate this disease in the whole province are needed.

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Table 13

Treatment and control on filariasis with DEC.

Year	No. of treatment on microfilaremics	No. of administration	No. of medicated table salt
1953-1969	416,926		
1970-1972	453,611		
1973-1976	131,289		56,129
1977-1986	305,703	4,175,785	2,418,377
Total	1,307,529	4,175,785	2,474,506

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