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Lymphatic Filariasis in Thailand. A Review on Distribution and Transmission

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Introduction

As early as 1919, MENDELSON (20) mentioned in his paper on "Tropical diseases observed in Siam" fever and elephantiasis in connection with microfilaraemia in Thailand. The disease causing filariae, however, were not further specified. Over 30 years later IYENGAR (17) conducted a survey on human filariasis in four southern provinces on the peninsula of Thailand. Of a total of 4,112 inhabitants examined, 21% proved to be infected with microfilariae of *Brugia malayi* and 5.6% showed signs of elephantiasis. Only in one person, a young Chinese man, were microfilariae of *Wuchereria bancrofti* observed. IYENGAR assumed that this infection must have had been acquired in China before the man immigrated to Thailand. During these early investigations no attention was paid to the periodicity of the parasites. First reports on periodic and subperiodic forms of *B. malayi* from Thailand were only published in 1961 by NAIR and CHAYABEJARA (21) and in 1963 by WONGSATHUAYTHONG et al. (27), respectively. The latter group also reported several cases of bancroftian filariasis from South Thailand, not far from the Thai-Malaysian border. The first endemic area of bancroftian filariasis with microfilariae showing a subperiodic behaviour was described by HARINASUTA et al. (14) from an area located north-west of Bangkok.

Obviously *B. malayi* causes lymphatic filariasis in some foci while *W. bancrofti* is responsible in others. This paper reviews the present knowledge on the distribution and transmission of the various forms of lymphatic dwelling filariae in Thailand.

Rural Malayan Filariasis

Clinical symptoms of filariasis caused by *B. malayi* in Thailand are in the early phase enlargements of inguinal lymph glands due to repeated inflammations and fever. The fever, however, can spontaneously subside in a few days. At a later stage, the onset of elephantiasis, mainly affecting the lower limbs, may commence. This usually occurs in people aged between 20 and 30 years. Upper extremities and genitalia are seldomly involved. According to HARINASUTA (9) elephantiasis is more often found in females than in males. He reported a ratio of 1.6 : 1.0, but the findings from GUPTAVANIJ et al. (8) indicate that the distribution of elephantiasis between the sexes varies from region to region and, as an average, it seems to be balanced.

Periodic *B. malayi*

This species has not been described from middle or northern Thailand but it is the most common filarial parasite in man on the peninsula in South Thailand. Distribution, prevalence and transmission have been studied in this area by several investigators at different times. IYENGAR (17) did not differentiate between the periodic and subperiodic *B. malayi* but it can be assumed that the majority of infected cases he observed during 1952 in the four southern provinces Surat Thani, Nakhon Si Thammarat, Phattalung and Pattani belonged to the periodic form. The observed rates of microfilaria carriers in the provinces were rather high varying between 10.0 and 28.6% (Tab. 1). HARINASUTA (9) compiled data on the prevalence of microfilaria carriers from Chumphon, Surat Thani, Nakhon Si Thammarat, Phattalung and Narathiwat for the years

Table 1:

Prevalence of microfilaria (mf) carriers in different provinces of Thailand.
Year of investigation: mf carrier % (number examined persons [n. a. = not available])

Province								
Mae Hong Son							90 : single cases	
Lamphun							87 : 0,3	(1435)
Tak							85 : 1,5	(1970)
Kanchanaburi			68 : 10,4	(2073)	75 : 9,0	(410)	84 : 2,0	(n. a.)
					79 : 4,0	(2026)		
Chumphon			64 : 14,1	(n. a.)				
			66 : 2,3	(20115)			83 : 0,1	(n. a.)
Ranong					71 : 0,04	(2666)		
Phangnga					71 : 0	(5048)		
Surat Thani	52 : 15,8	(727)	63 : 26,4	(n. a.)			84 : 0,4	(n. a.)
Phuket					71 : 0	(5958)		
Krabi					71 : 0,02	(4327)		
Nakhon Si Thammarat	52 : 16,8	(1613)	61 : 7,7	(n. a.)			84 : 0,09	(n. a.)
Trang					71 : 0	(5323)		
Phattalung	52 : 10,0	(160)	62 : 16,7	(n. a.)			84 : 0	(n. a.)
Satun					70 : 0	(2446)		
Songkhla					71 : 0,08	(7876)		
Pattani	52 : 28,6	(1612)			70 : 1,6	(4900)		
					71 : 8,0	(n. a.)	84 : 0,34	(n. a.)
Yala					70 : 0,04	(2831)		
Narathiwat			63 : 11,1	(n. a.)	70 : 2,8	(3287)	84 : 0,56	(n. a.)

1961 to 1964. The published rates varied between 7.7 and 26.4% (Tab. 1). Although the numbers of examined inhabitants are not listed, these data indicate that the infection rates were roughly within the same range as they were about ten years before.

HARINASUTA also stated in this compilation an infection rate of 14.1% for the province Chumphon in 1964. Later, together with his coworkers (12) he published a mean microfilaria carrier rate of only 2.3% for the same province as a result of a survey on 20,115 inhabitants conducted during 1964 to 1966.

An extensive survey on the prevalence of filariasis in southern Thailand including ten provinces has been described by GUPTAVANIJ et al. (8). These investigations have been conducted in 1970 and 1971 and between 2,446 to 7,876 inhabitants were examined in each province. Prevalences of microfilaria carriers were determined for each province and varied between 0 and 2.8% (Tab. 1). Additionally, HARINASUTA reported a microfilaria carrier rate of 8.0% for Pattani in 1971 , but GUPTAVANIJ et al. (8) registered in the same province in 1970 only 1.6% microfilariaemias in 4,900 examined inhabitants. Dinstinctly lower prevalence rates were reported for 1983 and 1984. They varied between 0 and 0.56% in six provinces in southern Thailand (9), however, the number of persons examined are not documented. A review published by SUCHARIT in 1988 (22) on the filarial infection rates from different districts and cantons, before and after treatment with DEC, supports the impression that the prevalence of *B. malayi* infections in general, decreased dramatically in this area compared to the findings of earlier investigators. Just so rates of microfilaria carriers up to 0.85%, 0.05%, 0.41% and 1.93% were recorded in 1985 to 1987 in some localities in Surat Thani, Nakhon Si Thammarat, Pattani and Narathiwat respectively (22). In 1990 UCHIYAMA et al. (24) published a list on microfilaremic patients from six districts of the Narathiwat province. The authors refer to a total of 168,567 examined inhabitants, 0.37% of whom proved to be infected with microfilariae. The rate of microfilaria carriers in the districts varied between 0.11% and 0.52%, while the numbers of examined persons per district varied between 4,384 to 51,038. Although the authors gave no in-

formation on the periodicity of the parasites, it is likely that periodic *B. malayi* was the dominant form.

These results, from various surveys, reveal that periodic *B. malayi* is patchily distributed on the peninsula in South Thailand. Endemic foci were identified in the six provinces Chumphon, Surat Thani, Nakhon Si Thammarat, Phattalung, Pattani and Narathiwat, where they were widely spread in rural areas showing varying rates of infection. Further, eight investigated provinces on the peninsula (Ranong, Phangnga, Phuket, Krabi, Trang, Satun, Songkhla, Yala), seem to be free of endemic filariasis (8). Single microfilaria carriers or persons with elephantiasis who were found during the surveys in these regions, proved to be immigrants from *B. malayi* endemic localities. These reports also show that, in general, microfilaria densities of the positive cases were low with about 10 mf per 40 cmm blood. Microfilariae were discovered in young (e. g. five years old girl) and old inhabitants (80 years old man) (8), however distinctly more often in males than in females.

Vectors and animal hosts of periodic *B. malayi*

IYENGAR (17) published a list of 11 mosquito species (4 *Mansonia,* 5 *Anopheles,* 1 *Culex*) from southern Thailand which had been found infected with filarial larvae. However, he did not report the stages of the larvae, therefore no vector species for *B. malayi* can be identified from that paper. HARINASUTA et al. (10, 12) observed infective *Brugia* larvae in *Mansonia indiana, M. uniformis, M. bonneae* and *M. annulata,* the infectivity rates were 0.283, 0.217, 0.162 and 0.036%, respectively. Recent compilations on the mosquito fauna of Thailand from API WATHNASORN (1) as well as from TSUKAMOTO et al. (23) do not include *M. annulata,* although this species is listed in several publications (e. g. 8, 9, 11). No other mosquito species could be incriminated as a vector for periodic *B. malayi* in southern Thailand. This might also explain why *B. malayi* is mainly endemic in the provinces of the eastern coast of the peninsula, where numerous permanent or temporary swamps with aquatic plants are found. Such biotops, which provide excellent breeding places for *Mansonia* mosquitoes, are rare on the west coast. Consequently *Mansonia* is much less frequent in the western provinces which are almost free from filarial infections (8).

In several surveys blood specimens of domestic as well as of some wild animals were examined for microfilariae of *B. malayi* (8, 10, 11, 12). HARINASUTA et al. (12) found *B. malayi*-like microfilariae in two cats in an area endemic for periodic *B. malayi*. One female worm resembling *B. malayi* was obtained when one of the cats was sacrificed.

Subperiodic *Brugia malayi*

This form of *B. malayi* has a very scattered distribution occurring in only three provinces on the peninsula of South Thailand. The first report of subperiodic *Brugia* was published by WONGSATHUAYTHONG et al. (27) in 1963 who found this parasites in the Narathiwat Province near to the Thai-Malaysian border. GUPTAVANIJ et al. (6) conducted investigations on the prevalence of the subperiodic form in the same province. Blood examinations of 3,287 persons revealed a microfilariae carrier rate of 2.7%; the elephantiasis rate was 1.2%. Studies on periodicity showed that the microfilariae had nocturnally, sub-periodic behaviour with the peak counts between 20.00 to 22.00 hours. These observations were confirmed in 1977 by GUPTAVANIJ and HARINASUTA (5) who found subperiodic *Brugia malayi* microfilariae in carriers from Narathiwat but not from Pattani. VASUVAT et al. (25) described the subperiodic form from the province of Nakhon Si Thammarat and GUPTAVANIJ et al. (7) reported subperiodic *B. malayi* from some villages in the Banduat canton in the province of Chumphon. GUPTAVANIJ et al. examined 443 persons for filarial infections, of whom 5.0% proved to carry microfilariae. The mean microfilarial density among positive cases was 6.7 mf per 20 cmm blood, the elephantiasis rate was 3.6%. Males were more often infected with microfilariae and more often showed elephantiasis than females. The periodicity of microfilariae was studied in three individuals. In all cases microfilariae showed a subperiodic behaviour. However, one person had a diurnally subperiodic form (peak count at 12.00 hours), whereas in the other two, as with inhabitants from other localities with periodic *B. malayi,* only the nocturnally subperiodic form was found.

At present it is difficult to decide how far filariasis treatment and vector control campaigns have reduced the prevalence and distribution of subperiodic *B. malayi*. The latest available compilations on filariasis from Thailand (9, 22, 24) do not differentiate between the two forms. However, we can assume that the prevalence decreased similary to that of periodic *B. malayi* as a result of various control measures.

Vectors and animal hosts of subperiodic *B. malayi*

GUPTAVANIJ et al. (6, 7) dissected mosquitoes found biting humans in the province of Narathiwat as well as of Chumphon. In Narathiwat *M. bonneae* and *M. dives* infected with third stage larvae from *B. malayi* were found while in the province of Chumphon *M. bonneae* and *M. uniformis* harboured infective *B. malayi* larvae. Younger filarial stages were also found in *M. annulata, M. dives* and even in one female of *Aedes butleri/dux*. Since *M. bonneae* carried most of the infective *Brugia* larvae in both areas it can be assumed, that this species is one of the main vectors for subperiodic *B. malayi* in South Thailand.

Blood specimens from a variety of animals have been examined during the investigations on subperiodic *B. malayi* (6, 7). In Chumphon one cat and in Narathiwat four cats harboured *Brugia*-like microfilariae. In none of the other animals studied were such microfilariae found. One can speculate that cats might be an animal reservoir for this *Brugia* form in the endemic areas in South Thailand.

Rural Bancroftian Filariasis

Clinical signs of infections with *Wuchereria bancrofti* in Thailand are mainly seen in men. Funiculo-orchitis, hydroceles and chyluria are the dominating symptoms; elephantiasis of extremities has not yet been reported.

Infections with *Wuchereria bancrofti* microfilariae have been reported from South Thailand where they have been found occasionally, mostly in immigrants from other areas with endemic filariasis. IYENGAR (17) registered *Wuchereria bancrofti* in a young Chinese in the province of Pattani. WONGSATHUAYTHONG et al. (27) reported several cases from Narathiwat not far from the Thai-Malaysian border and GUPTAVANIJ et al. (8) mentioned one man from Ranong who had bancroftian microfilariae but was a resident from a village situated near to the Thai-Burmese border. However, the authors did not comment on the periodicity of the bancroftian microfilariae they had found. Probably based on the findings from WONGSATHUAYTHONG et al. (27) HAWKING (16) assumed in his 1976 published review on the worldwide distribution of filariasis that the periodic type of *W. bancrofti* is endemic in Thailand. However, further reports confirming the presence and transmission of the periodic form of this parasite are needed before endemicity of periodic *W. bancrofti* can be considered as proven in Thailand.

Subperiodic *Wuchereria bancrofti*

In 1965 an endemic area of subperiodic bancroftian filariasis was discovered in Kanchanaburi Province (14), a rural, high, hilly and semi-forested region. Several villages close to the Thai-Burmese border showed microfilariae carrier rates between 3.8% and 27.8%. The mean microfilarial density in positive cases was about 30 mf per 40 cmm blood. Males were significantly more often infected than females. Clinical symptoms were almost exclusively reported from men. There were mainly funiculo-orchitis and hydroceles. A few women had chyluria. The microfilariae showed a nocturnally subperiodic behaviour with peak counts at 18.00 - 22.00 hours. A resurvey in one of the endemic areas of the same province conducted in 1979 revealed a microfilaria carrier rate of 4% from a total of 2,026 examined persons (13) and GOULD et al. (4) observed between 1973 and 1975 in 9% of 410 inhabitants of five villages bancroftian microfilariae. According to HARINASUTA control measures against bancroftian filariasis reduced the microfilarial rates of *W. bancrofti* among the villagers in Sankla Buri district, one of the endemic areas of *W. bancrofti* in the Kanchanaburi Province, from 13.1% in 1965 to 1968 and 10.2% in 1978 to 2.0% in 1984.

Further investigations on the prevalence of *W. bancrofti* were conducted by KHAMBOONRUANG et al. in the provinces Tak (19) and Lamphun (18) both located in Northwest Thailand. In Tak, blood specimens of 1,970 villagers were examined of which 1.5% revealed microfilariaemia. All were diagnosed as being *W. bancrofti*. The investigations in Lamphun Province included 1,435 inhabitants of whom only five men (0.35%) were found with bancroftian microfilariae. These individuals, however, were immigrants. Studying the periodicity in these two northwestern provinces of Thailand the investigators stated that *W. bancrofti* was nocturnally subperiodic, although the peak parasitaemia in Tak province was somewhat earlier (18.00 hours) than that described by HARINASUTA et al. (14). Additionally, reports from Chiang Mai that bancroftian microfilariae were observed in blood smears from malaria patients from the province of Mae Hong Son, indicate that *W. bancrofti* is likely to be endemic in more areas than presently known.

Vectors and animal hosts of subperiodic *W. bancrofti*

Mosquitoes from several species were caught in the endemic area and examined for filarial larvae (14). Only *Aedes niveus*–subgroup harboured infective larvae of *W. bancrofti*. Investigations from GOULD et al. revealed, that several females of *Aedes harinasutai* from the *Ae. niveus*–subgroup and *Ae. desmotes* carried infective larvae. Thus bancroftian filariasis in Northwest Thailand is obviously *Aedes* transmitted although third stage larvae of *W. bancrofti* werde also found in two females of *M. dives* (4). However, experimental studies on further potential vectors showed that *Aedes togoi* as well as several *Anopheles* species could function as well as vectors for this rural *W. bancrofti* strain (15).

The blood of numerous cats and several dogs was examined by HARINASUTA et al. (14), but no microfilariae of *W. bancrofti* were found. It can be assumed that there are no animal hosts for this parasite. However, it must be kept in mind that HARINASUTA et al. (13) succeeded in breeding this filarial strain in leaf monkeys *(Presbytis melalophos* and *P. cristata)* which even produced microfilariae.

Urban *Brugia* Filariasis?

Lymphatic filariasis in Thailand has been considered as a disease of the rural population. However, recently *Brugia* filariae have been discovered in a rather high percentage (14.3 – 52.2%) of domestic cats in Lat Krabang, a suburb of Bangkok (2). The microfilariae of these parasite resemble those of *Brugia pahangi,* the adult males however are *B. malayi*–like (26). Before these findings infections with lymphatic filariae were known neither from animals nor from humans in Bangkok.

The human population of Bangkok amounts roughly to nine million inhabitants. Due to climatic and geographic conditions, as well as a consequence of environmental factors, mosquitoes find numerous suitable breeding places. Therefore the human population is exposed to extremely high numbers of mosquito bites from different species, particularly those from the genera *Culex* and *Mansonia. Mansonia* species are the main vectors for *Brugia* in the southern parts of the country and they are also expected to be responsible for the transmission of the urban strain of *Brugia* in Bangkok. The high infection rates among the cats in the suburb of Bangkok together with a high vector density could favour the transmission and adaptation of this still unidentified *Brugia* species to man, thus establishing an urban filariasis in Thailand beside the already existing rural forms of lymphatic filariasis.

Discussion

The compilations from HARINASUTA (9) and SUCHARIT (22) as well as the reports from KHAMBOONRUANG et al. (18, 19) and UCHIYAMA et al. (24) indicate that lymphatic filariasis is still widely distributed in various parts of Thailand and that even in these days new endemic areas can be discovered. However, as a consequence of control measures such as treatment with DEC and vector control infection rates, microfilarial density and transmission seem to have dramatically decreased, thus reducing the clinical significance of filiariasis in the endemic areas.

The latest publications might raise the impression that lymphatic filariasis is under control in Thailand and therefore of no further importance. But the reports are mainly based on the examination of blood drops and, in some cases, on quantified blood smears but not on filtration techniques. During the last 20 years various investigators (e. g. 3) have demonstrated that the filtration method is much more sensitive than blood smear methods for identifying especially microfilaria carriers with low parasite densities. Therefore the use of the filtration technique is indicated for defining prevalence rates based on microfilaraemias. This is particulary true when the effectiveness of treatment campaigns against microfilariae has to be assessed. Since this sensitive tool has not or only scarcely been employed in epidemiological surveys on filariasis in Thailand, we cannot exclude the possibility that the prevalence rates for filarial infections in some areas are distinctly higher than reported.

As *Brugia* parasites have recently been discovered in cats in a suburb of Bangkok, lymphatic filariasis which has been considered as a rural disease in Thailand, shows new aspects. Adaptation of this still unidentified *Brugia* form to man cannot be excluded in an environment with a high vector density and a densely crowded human population. If this parasite proves to be a strain of *B. pahangi,* as the characteristics of the microfilariae suggest, this risk might be minor. However, if it should belong to *B. malayi,* as the similarity of the male worms indicates, the potential for establishing an urban form of Malayan Filariasis in Thailand would be high.

Summary Various investigations demonstrate that at least three forms of lymphatic dwelling filariae are endemic in Thailand in different regions. Periodic and subperiodic *Brugia malayi* are found in the southern peninsula and subperiodic *Wuchereria bancrofti* is present in the northwestern parts of the country. The prevalence of microfilariae carriers, however, is rather low. *Mansonia indiana, M. uniformis, M. bonneae* and *M. annulata* have been described as vectors for periodic *B. malayi. M. bonneae* seems to be the main vector for the subperiodic *Brugia* form, although the other *Mansonia* species carried developing or infective larvae as well.

W. bancrofti third stage larvae were found in the *Aedes niveus*-subgroup, particularly in *Ae. harinasutai.* Additionally *Ae. desmotes* and *M. dives* proved to be infected with third stage larvae of this filarial species. *Brugia* like microfilariae and adults were found in cats from localities endemic either for periodic or subperiodic *B. malayi.* No wild or domestic animal, however, was infected with *Wuchereria* like filariae. A yet unidentified *Brugia* species has been discovered in cats in a suburb of Bangkok. The rather high prevalence and high mosquito density increase the risk that this filaria might get adapted to man.

Key words Review, Thailand, lymphatic filariasis, *Brugia malayi, Wuchereria bancrofti,* distribution, prevalence, vectors, hosts.

Zusammenfassung

Die lymphatische Filariose in Thailand. Eine Übersicht über Verbreitung und Übertragung

Die lymphatische Filariasis ist in Thailand eine typische Erkrankung der ländlichen Bevölkerung. Als Erreger wurden auf der südlichen Halbinsel die periodische und subperiodische Form von *Brugia malayi* und im Nordwesten des Landes die subperiodische Form von *Wuchereria bancrofti* nachgewiesen. Die Prävalenzraten sind aber im Mittel niedrig, obwohl klinische Symptome der Filariasis durchaus zu registrieren sind. Als Überträger für die periodische Form von *B. malayi* wurden *Mansonia indiana, M. uniformis, M. bonneae* und *M. annulata* beschrieben. *M. bonneae* scheint der wichtigste Überträger für die subperiodische Form dieser Filarienart zu sein, obwohl auch andere *Mansonia*-Arten Infektionslarven aufwiesen.

W. bancrofti wird in erster Linie durch *Aedes*-Mücken übertragen, dabei scheinen *Ae. harinasutai* aus der *Ae. niveus*-Subgruppe und *Ae. desmotes* zu dominieren, aber auch *M. dives* wurde infiziert gefunden. *B. malayi*-ähnliche Mikrofilarien und adulte Würmer wurden in Katzen gefunden, die aus Gebieten stammten, in denen entweder die periodische oder subperiodische Form von *B. malayi* endemisch war. *W. bancrofti*-ähnliche Filarien wurden weder in Wild- noch in Haustieren aus dem Nordwesten Thailands beschrieben. Aufgrund der Tatsache, daß in Bangkok *Brugia*-Filarien einer bisher noch nicht eindeutig identifizierten Spezies in mehrerern Katzen gefunden wurden, kann die Möglichkeit einer Adaptation des Parasiten an Menschen in diesem Ballungsgebiet mit zahlreichen filarienübertragenden Stechmückenarten nicht ausgeschlossen werden.

Schlüsselwörter Übersicht, Thailand, Lymphatische Filariasis, *Brugia malayi, Wuchereria bancrofti,* Verbreitung, Prävalenz, Überträger, Wirte.

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