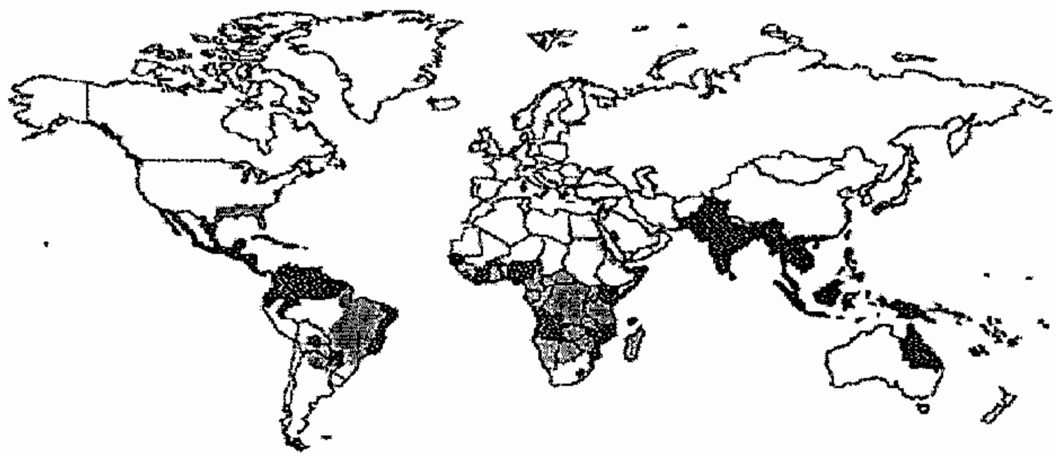
CHAPTER 1

INTRODUCTION

Dengue fever is one of the most rapidly expanding diseases of the tropical and subtropical regions of the world, with over two billion people at risk of infection and millions of cases occurring every year, especially in Southeast Asia, the Western Pacific and the Americas regions (Figure 1.1). The severe form of the disease, DHF, is a leading cause of hospitalization and death among children. Dengue fever and dengue heamorrhagic fever (DHF) are caused dengue viruses and transmitted exclusively from human to human by the bite of infected mosquitoes of the *Aedes* family (Ramirez-Ronda, 1994). In view of the gigantic public health problem created by DHF, the interest of policy makers, scientists and administrators in the prevention and control of the disease have increased many-fold. (Ko Ko, 1993)

Figure 1.1 World distribution of *Aedes aegyti* and recent dengue activity, 1997.



Source: Gubler, D.J. 1997. "Dengue and Dengue Haemorrhagic Fever: its History and Resurgence as A Global Public Health Problem", In *Dengue and Dengue Haemorrhagic Fever*, p.3.

The first outbreak of DHF in Thailand occurred in Bangkok-Thonburi and nearby areas in 1958. Almost 2500 cases and a 10% case fatality rate were recorded (Thongcharoen and Jatanasen, 1993). The morbidity rates of DHF have increased yearly. In 1998 the number of cases recorded was 98,123 and the morbidity rate was 161.34 per 100,000 population. In addition the number of deaths was 341 cases and the mortality rate was 0.35% (reported on 21 September 1998) (Office of the Permanent Secretary for Public Health, 1998).

Reports on the larvae density and breeding site of the DHF vector indicated that *Aedes aegypti* was most found indoors, particularly in water containers. In addition, *Aedes* larvae density had been found to have a positive correlation with breeding site and DHF incidence (Sangtharathip, 1997).

The epidemic pattern of DHF in Pattani province located in the south of Thailand has alternated by year from 1993 to 1997. The highest number of cases was recorded in 1995, particularly in Muang, Kok Pho, and Nong Chik districts, with morbidity rates of 57.1, 34.5 and 31.7 per 100,000 population, respectively. In 1996, the number of cases was highest in Kok Pho, Panarhe and Muang districts with morbidity rates of 11.4, 7.6 and 4.9 per 100,000 population respectively. In 1997, the surveillance report of Pattani Public Health Provincial Office revealed the highest incidence of DHF in September. The disease has spread to all districts in Pattani. Furthermore the DHF transmission always occurs in the same area, for example Kok Pho, and Maung districts having a mixed population of Buddhists and Muslims (Pattani Public Health Provincial Office, 1997).

From the above information it is of interest to determine why some areas in Pattani always have DHF transmission yearly while other areas do not. Furthermore, water consumption between Buddhist and Muslim people, having differences in way of living, tradition and cultures, has not been clearly perceived.

Thus, water consumption characteristics and larval density of DHF vectors in both DHF transmission and non-DHF transmission villages, as well as the relationship between these factors and DHF transmission, should be thoroughly investigated, to gain more understanding of the causes of DHF transmission among Buddhist and Muslim populations.

Objectives

1. To investigate the water consumption characteristics and larval distribution of dengue vectors in both the DHF transmission and non-DHF transmission villages.
2. To investigate the water consumption characteristics and larval distribution of dengue vectors in both the Buddhist and Muslim villages.
3. To examine the relationship between the water consumption characteristics and the larval distribution of dengue vectors.

Research Hypothesis

1. The water consumption characteristics and larval distribution of dengue vectors in the DHF transmission and non-DHF transmission villages are different.
2. The water consumption characteristics and larval distribution of dengue vectors in the Buddhist and the Muslim villages are different.
3. There is a relationship between the water consumption characteristics and larval distribution of dengue vectors.

Definition of Terms

House Index (H.I.) is the percentage of houses where the larvae are found.

Container Index (C.I.) is the percentage of containers where the larvae are found.

Breteau Index (B.I.) is the percentage of infected containers per 100 inspected houses.

Stegomyia Index (C.I.) is related to the number of infected containers per 1,000 persons in the surveyed population.

A Buddhist village is a village with at least 90% Buddhist population.

A Muslim village is a village with at least 90% Muslim population.

A Dengue Haemorrhagic Fever (DHF) transmission village is a village with at least one DHF case in the last 5 years (1993-1996).

A Non-DHF transmission village is a village with no DHF case in the last 5 years (1993-1996).

The water consumption characteristics means type of water for drinking and other use, type of container, number of containers, location of container, and period of changing water in the container.

A Positive container is a container containing at least a single larva.

Background and Rationale

Dengue is one of the most important insect-borne viral diseases in the world, and epidemics have led to extensive illness, death, and economic disruption in almost all tropical regions. Dengue fever is an endemic mosquito-borne viral disease of the tropical and subtropical regions of the world, characterized by a variety of clinical manifestations, such as a sudden onset fever with chills, headache, retroocular pain, general malaise, myalgia, arthalgia, and often an exanthem. A more severe clinical form of the disease caused by some viruses is the dengue haemorrhagic fever/ dengue shock syndrome (DHF/DSS), which is currently a major cause of morbidity and mortality and is characterized by haemorrhagic manifestations, circulatory collapse, and eventually death if not treated appropriately (Ramirez-Ronda, 1994).

1. Etiology

The etiology agent of DHF is a distinctive, more severe, disease associated with an infection with the dengue virus. There are four serologically related RNA viruses that belong to the Arbovirus classification, the majority of them belonging to the Togaviridae, Bunyaviridae, or Flaviviridae families. Dengue viruses are now classified under the family Flaviviridae, genus Flavivirus (Ramirez-Ronda, 1994). There are four distinct types of dengue virus, namely dengue virus type 1 (DEN-1), dengue virus type 2 (DEN-2), dengue virus type 3 (DEN-3) and dengue virus type 4 (DEN-4) (Thongcharoen, Wasi and Putharathana, 1993).

2. Vector

DHF is transmitted exclusively from human to human by the bite of infected mosquitoes of the *Aedes* family (Ramirez-Ronda, 1994). In Thailand the *Aedes aegypti* was incriminated as the main vector and the *Aedes albopictus* was a secondary vector of DHF (Division of General Communicable Disease Control, 1990).

3. Clinical Symptoms

Clinical diagnosis of DHF can be made with 90-95 per cent confidence using the following criteria which are based on the presence of major manifestations and the course of illness, which is stereotyped. Clinical criteria are as follows.

3.1 Fever – acute onset, high, continuous, and lasting two to seven days in most cases.

3.2 Haemorrhagic manifestation, including at least a positive tourniquet test and any of the following: scattered petechial, confluent petechial rash, epistaxis, gum bleeding, and/or melena/haematemesis.

3.3 Enlargement of the liver

3.4 Shock – manifested by a rapid and weak pulse with narrowing of the pulse pressure (20 mmHg or less) or hypotension, with the presence of cold clammy skin and restlessness (Nimmannitya, 1993).

4. Prevention and Control

There are three factors needed for an epidemic of dengue fever to occur (Ramirez-Ronda, 1994)

4.1 The dengue virus

4.2 The mosquito vector

4.3 People susceptible to the infection

From these three factors and in the absence of an effective vaccine, eradicating the principal vector mosquito, *Aedes aegypti*, and avoiding mosquito bites constitute the first line of attack and only effective method for dengue prevention.

Aedes aegypti is a peridomestic mosquito with short flight range that breeds almost exclusively in artificial habitats such as water storage vessels, flower vases, old tires, animal watering pans, planters, gutters, bromeliads, and other discarded household items that collect rainwater. Eliminating all potential habitats in and around the house is one of the most important preventive methods. The male feeds on flowers and fruits, but the female feeds mainly on human blood, so it is principally the female who transmits the disease. The mosquito acquires the infection by ingesting the blood from a viremic host, and then the virus rapidly infects most tissues of the mosquito, multiplying in salivary glands. The time from the initial blood meal until the virus is produced in the salivary glands is called the extrinsic incubation period, lasting approximately 8 to 14 days, in which the mosquito cannot transmit the infection by a bite. Thereafter, the mosquito bite remains infectious for the lifetime of the insect, which is usually several weeks (Ramirez-Ronda, 1994).

Aedes albopictus are generally found biting outdoors and, like *Aedes aegypti*, exhibit two peaks of biting activity, in the early morning and late afternoon. They are found in cut bamboo stumps, tree holes, coconut shells, and clay pots (Pant and Self, 1993).

The mosquito passes through four life cycles: egg, larvae, pupa, and adult. The eggs are deposited over the water surface (approximately 30 to 50), and once the embryonic development is completed, which may last from 48 hours to 5 days, the eggs are capable of resisting long periods of dehydration, up to one year. This is one of the principal obstacles to the control of the mosquito since this ability permits the eggs to be transported long distances in dry recipients. The larvae develop in a period of 2 to 3 days and the pupa in 5 to 10 days, emerging as adults two days later (Ramirez-Ronda, 1994).

Methods of prevention and control of mosquito DHF vectors are as follows.

1. Chemical methods

Chemical methods are useful for prevention and control of the DHF vector from larvae to adult mosquito. Control of larvae can be accomplished through larviciding domestic water jars by treatment with a DDT suspension at a dose of one mg/1, one percent of temephos sand granules (SG) (Bang and Tonn, 1993). For control of the adult mosquito, a treatment with DDT, Pirimiphosmethyl, Fenitrothion, Malathion, and deltacide spraying indoors and outdoors have been conducted (Division of General Communicable Disease Control, 1993).

2. Biological methods

Biocontrol agents including *Bacillus thuringiensis* H14 (a spore-forming bacteria) and larvivorous fish are potentially useful for control of *Aedes aegypti* (Bang and Tonn, 1993).

3. Environmental methods

The environmental approach to source reduction is labour intensive, but if well planned can reduce *Aedes aegypti* populations. This includes elimination or protection from the rain of every receptacle around the house that may accumulate water, use of metallic screens indoors and windows, and use of aerosol insecticides, as well as mosquito repellents, when going outdoors. These activities may be promoted as community clean-up campaigns or as anti-*Aedes aegypti* programmes (Bang and Tonn, 1993).

It is important that the activities are well organized and promoted. Since most artificial breeding sites are soon replaced, there is a need for constant source reduction. One method of accomplishing greater involvement on a continual basis is through legal means. Source reduction in permanent drinking water containers can be achieved through using proper fitting lids and screening all openings into the containers through which female mosquitoes might enter (Bang and Tonn, 1993).

Literature Review

The Division of General Communicable Disease Control of Thailand surveyed breeding sources of *Aedes* mosquito indoors and outdoors in all regions of Thailand in 1990, and reported that *Aedes aegypti* was found in 70.8% of water containers, in 15.7% of animal watering pans and 13.5% of other containers such as flower vases and old tires (Sangtharathip, 1998).

Using a retrospective study, Sangtharathip (1997) determined a correlation between larval and adult indices, obtained from entomological surveillance in Udorn Thani, Songkhla, and Lampang, and cases of DHF reported in 1992 – 1995. In Udorn Thani, all indices, except House Index, were found to correlate well with DHF cases. Rarous Rate (RR) showed the highest correlation ($r = 0.69$, $p < 0.01$). In Songkhla, House Index showed the highest correlation (in communities, $r = 0.82$; in schools, $r = 0.003$), followed by Container Index (in communities, $r = 0.76$; in schools, $r = 0.38$). However, in Lampang no correlation was found between these parameters. Residential areas often had higher index levels than commercial areas. In addition, the correlations between rainfall and House Index, Container Index, and Breteau Index were high in Sobprap and Hangchat Sanitaries, but were relatively low in Muang Municipality. Besides, most indices fluctuated seasonally with major or minor peaks during rainy months.

Wangme (1995) surveyed breeding sites of the *Aedes* mosquito in 203 households in Songkhla province during 9-10 March 1995. In 744 surveyed containers, they found that 142 containers (19.1%) had larvae in 68 households (33.5% of all surveyed houses). This corresponds to 69.9% of containers per house having larvae. The DHF vector larvae most observed was *Aedes aegypti* in 129 containers (90.8% of all containers found the larvae). However *Aedes albopitus* was found only in 13 containers (9.2%). Most indoor containers had more *Aedes aegypti* larvae (69.9%) than *Aedes albopictus* (53.8%). In addition, in the dry season the density of the breeding site of mosquito larvae was found to be high (Breteau Index =69.9).

Dulyapaire and Wongskul (1990) investigated the DHF vector density among villages around the Thai-Malaysian border during the dry season and the rainy season in 1988. In the dry season they observed water containers, for breeding of *Aedes* mosquito, with an average of 5-6 containers per house (Suking Kolo, Takbai, Wang, Sukeerin and Jarnag Districts in Naratiwat province). The HI values were found to be approximately 26, 31, 24, 40, and 27, respectively. The RI values were 9, 12, 9, 13, and 9, respectively; the BI values were 51, 64, 45, 76, and 72, respectively; the Landing Rate values were 4, 1, 0.5, 2, and 0.05, respectively. Not surpassingly in the rainy season they found that more containers having water were observed than in the dry season, with an average of 9-12 containers per house. The HI values were approximately 31, 48, 45, 40, and 37, respectively. The RI values were 11, 15, 12, 14, and 10, respectively. The BI values were 66, 107, 85, 97, and 55, respectively, and the Landing Rate values were 2, 2, 0.2, 1.1, and 1, respectively. The density of DHF vector in the rainy season was found to be slightly higher than that in the dry season. The number of water containers having the larvae located indoors and outdoors were similar in the dry season ($p>0.05$). For the rainy season, the number of water containers located outdoors having the larvae (average of 14.6%) were observed to be significantly higher than those located indoors (average of 11.2%) ($p>0.05$).

Kityapong and Strickman (1993) made a survey of larvae *Aedes aegypti* (L) and *Aedes albupitus* (Skuse) in dengue transmission villages (about 186 households) in the rainy season. The containers having larvae, type of water storage containers, water level, type of lid and location of container were recorded. They found that the number of containers having larvae were in direct proportion to the total number of containers in the house. In containers having larvae, there was no statistical difference in the number of larvae found in the standard water jar (200-liter) and in the small water jar (100-liter). Moreover, they found that containers placed inside had more larvae than containers placed outdoors and containers placed under eaves or in a bathroom. The standard water jar placed outdoors with an aluminum lid was found to have larvae more often than the water jar with no lid.

Chareonsook, et al, (1985) studied the prevalence of *Aedes* mosquito in big cement jars and rain water tanks in Muang district, Khon Khaen province. In 150 households under survey, there were altogether 1,552 water containers, giving an average of 10.3 containers per house. *Aedes* larvae were found in all houses (house index = 100), the container index was 62.9%, and the breteau index was 650.7 infected container per 100 household. The average percentage of big jar with larvae was 32.3 and that of rainwater tanks was 4.0. Containers placed in the houses had lower containers index than those outside the houses. In addition, containers with coverings had lower container indices than those without covering.