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Tourism and Dengue Incidences: Would Tourism Increase Mosquito Breeding Sites?

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Abstract

In this study, we investigated how tourism affecting mosquito diversity and their main breeding sites in tourist areas of Pak Meng Beach, Trang Province by comparing mosquito larval diversity, abundance and breeding sites between houses and shops/resorts. The breeding sites were randomly selected ten houses or hotels at 0, 200, 400, 600, 800, and 1000 m. from the beach with a total of 60 houses or hotels. We collected all mosquito larvae from both indoor and outdoor containers, identified types of water containers and mosquito larvae up to genus or species level under stereo microscopes. Our results showed that four mosquito larvae species were found: Aedes aegypti (n=63), Aedes albopictus (n=464), Culex spp. (n=217), and Toxorhynchites spp. (n=3). The main breeding sites were plastic buckets, coconut shells, tires and small earthen jars. Mosquito larvae were found most at 400 and 600 m. from the Pak Meng Beach. The number of mosquito larvae at the shops/resorts at 200 m. from the beach was significantly higher than houses. This indicates that tourism has some effect by increases mosquito breeding sites.

Keywords: *distance, tourist area, mosquito larvae.*

1. Introduction

Dengue fever (DF) is endemic in popular tourist destination in most tropical parts of the world. The incidence of epidemic and endemic dengue has increased worldwide (Hayes & Gubler, 1992). The current annual global incidence of dengue infection is 100 million patients per year. Factors have been implicated in the current increase in the incidence of dengue are tourism, urbanisation, overpopulation, crowding, poverty, and a weakened public-health infrastructure (Lifson, 1996). This impact varies and can be loss of life, medical expenditures, and loss of tourism as a result of negative publicity (Meltzer et al., 1998).

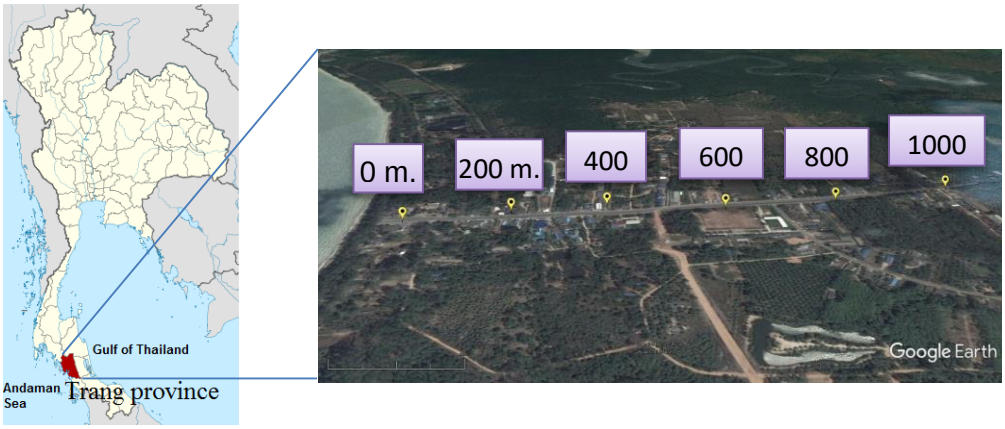
Tourism has become the world's largest business over the past century and is a significant contributor to economies worldwide. With rapid growth in tourism industires, tourist destinations need to have adequate insight into factors that influence tourism demand (Oduber et al., 2014). Several studies show that dengue can influence tourism (e.g. Cobelens et al., 2002; Wichmann et al., 2003, Schwartz et al., 2008) by reporting that dengue infections were frequent in travelers to endemic areas in Asia and returning with the vius back home. No studies have been investigated how tourism industries would lead to dengue outbreaks in Asia.

This is the first to study the impact of tourism industries leading to increases in accommodation, hotel decoration, water storage containers, and trashes which may lead to increases in the mosquito breeding sites in tourist attraction areas. In this study, we investigated how tourism affecting mosquito vector-borne diseases. We compared mosquito larval diversity, abundance, key breeding sites of mosquitoes between houses and hotels at 0, 200, 400, 600, 800 and 1000 m away from Pak Meng beach, southern Thailand.

2. Materials and Methods

Data Collection

Mosquito larval survey was conducted at Pak Meng beach in Trang, southern Thailand (7.505543º N, 99.313081º E) in July 2016 (Fig. 1a,b). From Pak Meng beach along the main road, we marked the positions every 200 to 1000 m on the Google Earth. Samples were collected in houses and hotels. There were ten houses/hotels per distances with a total of 70 households in this study.



(a) (b)

Fig. 1. *(a) map of Trang province, Thailand and (b) map of Pak Meng beach and distance for collecting data*

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All water containers were sampled for mosquito larvae both indoors and outdoors by using nets with mesh size of 0.55 mm. Very small water containers were emptied through the fishnet. Larger water containers were sampled by dipping the net in the water, starting at the top of the container and continuing to the bottom in a swirling motion that sampled all edges of the container (Preechaporn et al., 2006, 2007; Wongkoon et al., 2007). All live mosquito larvae were collected in plastic bags, taken to the laboratory, preserved and identified up to genus or species level using Rattanarithikul and Panthusiri's keys (Rattanarithikul & Panthusiri, 1994). In this study, the first, second instars and pupae were not analysed because immature mosquitoes at these stage could not be identified.

Statistical analysis

We used crosstab chi-square tests to test the ratio of mosquito larvae species in each distance and the abundance of mosquito larvae in breeding sites (indoor and outdoor containers). We used t-tests to test the differences in the number of mosquito larvae between houses and hotels. All significant tests were two tailed at a significant level of 0.05.

3. Results and Discussion

The numbers of *Ae. aegypti*, *Ae. albopictus* and *Culex* spp. Larvae were different in all distances (Table 1). The numbers of *Ae. albopictus* larvae were highest in most distances (at 200-600 and 1000 m from the beach). The numbers of *Culex* spp. larvae were highest in at 0 and 800 m from the beach (Table 1). At 200 m, there were higher total number of mosquito larvae in hotels than houses (Table 1).

Table 1. Mosquito larvae species and abundance from Pak Meng beach (P*<0.05)**

Distances from beach (m)	*Ae. aegypti*	*Ae. albopictus*	*Culex* spp.	Statistical test	Number of mosquito larvae		
					Hotels	Houses	t-test
0	15	29	34	χ^2_2 = 7.46*	19.50±12.45	0	
200	6	24	9	χ^2_2 = 14.31*	15.00±0.00	4.00±2.53	t_5=4.026*
400	3	208	0	χ^2_1 = 199.17*	54.33±33.02	24.00±29.70	$t_{3=}$1.04
600	1	177	134	χ^2_2 = 161.90*	55.00±60.81	40.80±47.86	t_5=0.335
800	20	8	35	χ^2_2 = 17.43*	0	10.67±10.35	
1000	18	18	5	χ^2_2 = 14.31*	3.00±1.41	11.67±10.60	$t_{3=}$-1.092
Statistical test	χ^2_5 = 32.18*	χ^2_5 = 508.51*	χ^2_4 = 242.78*	χ^2_{10} = 289.58*			

The dengue vectors in southern Thailand are primarily *Ae. aegypti* and *Ae. albopictus* (Thavara et al., 1996; Luemoh et al., 2003). We found a high number of *Ae. albopictus* larvae in most distances. This might be because *Ae. albopictus* is capable of breeding in a wide range of container types and waterholding containers. Our results indicate that tourism had strong impacts on major dengue vectors in southern Thailand.

Table 2. Mosquito larvae species and abundance in indoor and outdoor breeding sites (*P<0.05)

Breeding sites		*Ae. aegypti*	*Ae. albopictus*	*Culex* spp.
Hotels	Indoor containers	1	0	0
	Outdoor containers	17	272	80
Houses	Indoor containers	2	42	4
	Outdoor containers	43	150	133
		$\chi^2_1 =$ 51.571*	$\chi^2_1 =$ 311.027*	$\chi^2_1 =$ 201.295*

In both hotels and houses, there were more *Ae. albopictus* than other mosquito species (Table 2). *Ae. albopictus* larvae found mostly in outdoor containers (Table 2). Most mosquito larvae were found in plastic buckets, bottles. At 400 m., the abundance of mosquito larvae were found in many water containers such as small earthen jars, discarded tyres, plastic buckets and coconut shells. At 800 m. (all water containers from houses) most of mosquito larvae were found in earthen jars and 1000 m. most of mosquito larvae were found in and plant pots (Table 3).

Table 3. Mosquito larvae species and abundance in the water containers (*P<0.05)

Container type	Distances (m)					
	0	200	400	600	800	1000
Ant-guards						24
Bio-fermentation tanks		15				
Coconut shells			20	22		
Discarded tyres			22	9	6	
Earthen jars		10	27		61	
Flower vases				9		
Plant pots		16		4		66
Plastic buckets/bottles	28	54	21	52	11	10
Used cans/pots		5	10	4	22	

Our results support previous findings that *Aedes* mosquitoes have different key breeding sites (Wongkoon et al., 2005). This study clearly demonstrates that distances from the beach

influence container types. Tourists affect dengue transmitted diseases because tourists tend to littering trashes at tourist attraction sites. These trashes from tourists would become mosquito breeding sites when rain water gets in. In this study, trashes that were key breeding sites including plastic buckets, plastic bottles, used cans, used pots, and used tyres. The highest numbers of containers were plastic buckets, coconut shells, discarded tyres and earthen jars. Plastic containers were the most commonly used in the houses, hotels and resorts due to its low cost. Coconut shells were the main mosquito breeding sites which contained good food. These are known to attract ovipositioning females (Wilton, 1968; Beehler et al., 1992; Paradise & Kuhn, 1999). In addition, hotels tend to decorate their places with flower pots and earthen jars filled with water and water lilies.

4. Conclusion

The purpose of this study was ton investigate the influence of tourism on mosquito breeding sites. This study found that tourism has an impact on the types and abundances of mosquito larvae by increasing the number of mosquito breeding sites such as plastic bottles, used cans and coconut shells. Preventive actions and campaign are important parts of the mosquito control strategy, especially in tourist attraction areas.

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