Correlation between Oriental Rat Flea Abundance and Commensal Rodents in Three Different Geographical Regions in Bangkok, Thailand

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Background: *Fleas play important role as transmission vector of some important communicable and re-emerging diseases. Among them, plague is one of the highly virulent diseases transmitted by the oriental rat flea, Xenopsylla cheopis. The surveillance of commensal rats and flea species is done by calculating the "Flea index" as the risk indicator of plaque for the monitoring program.*

Objective: *To determine the distribution of oriental rat flea and commensal rodents and to study the correlation between their abundance and the geographical regions in Bangkok, Thailand.*

Material and Method: *Small rodents were trapped from fresh food markets in 3 different geographical regions in Bangkok during August 2009 by using cage mouse traps. Fleas were collected by back-combing the fur of each animal. The total flea index, specific flea index, Shannon-Wiener diversity index and percentage of trap success were calculated as data analysis.*

Results: *The data revealed that the average total flea index of the inner, middle, and outer regions in Bangkok were: 0.93±0.21, 1.39±0.36, and 1.06±0.44, respectively. The data also indicated that the specific flea index of commensal rodent hosts, Rattus norvegicus, Rattus rattus, Rattus exulans, and Suncus murinus were: 0.95±0.18, 1.28±0.64, 1.74±0.36, and 0.47±0.14, respectively. The number of collected fleas was positively correlated with the geographical differentiation of each region. In addition, the highest species diversity (H index) of rats and shrews appeared in the inner region. Percentage of trap success which indicated the density of reservoir hosts in the inner, middle and outer regions were: 20.63, 16.82, and 21.69%, respectively. Rattus norvegicus and Rattus exulans were the achievable hosts of oriental rat flea in Bangkok.*

Conclusion: *The inner region of Bangkok should be the priority for sanitation improvement to prevent a disease transmission.*

Keywords: *Xenopsylla cheopis, Flea index, Ectoparasite distribution, Rats, Shannon-Wiener diversity index*

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Oriental rat flea, *Xenopsylla cheopis*, is a parasite of rodents, mostly of the genus *Rattus*(1). It is an important vector of bacterial diseases, especially plague and murine typhus. Because of the convenient travel and trading, the flea-borne pathogens have been spread widely by rat-infested ships between countries. In urban plague, *Yersinia pestis* is transmitted by rat fleas to human population(2). In Thailand, there are almost no plague cases or very rare cases but the incidence of plague has been reported in neighbour countries including an outbreak in China(3-5). Murine typhus is a flea-borne disease caused by *Rickettsia typhi*(6). This disease has been reported among travellers returning from several countries including Thailand. The reservoir hosts of flea-borne pathogens are commonly rats, *Rattus norvegicus*, *Rattus rattus* and the insectivore *Suncus murinus*(1). The transmission occurs when the fleas have bitten on infected rodents and then bite to human.

The abundance of rat fleas and reservoir hosts are used to indicate the risk factor of flea-borne diseases. The commensal rats and flea species are quantified by calculating the flea index (an average number of all flea species per rodent hosts). The flea index is an indicator used to represent a potentially dangerous situation of plague risk to human(7). This

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index indicates that infected human and animal population should be monitored to prevent a disease outbreak.

The previous study on rat and shrew populations and the flea index in Bangkok in 2003 reported that the inner area had the highest rodent population and the highest flea index of 0.86[8]. These values are rather high which may conduct the inner area to be the high risk for disease transmission. Therefore, the sanitation of Bangkok should be improved.

The purpose of this study are to evaluate the distribution of the oriental rat flea and commensal rodents in Bangkok fresh food markets to determine the risk factor influencing transmission of flea-borne diseases and to analyse the geographical factors associated with flea abundance and commensal rodents at various sites.

Material and Method

Determination of sample sites

This study was conducted during August 6 to 28, 2009 in 133 fresh food markets covering 40 districts of Bangkok. One to forty-five markets were chosen as collection sites per day in that period of time. Base on the population density and location, Bangkok was divided into three regions which include 50 districts.

The inner region, the most crowded region is composed of 21 districts, i.e., Sampantawong (13), Bang Rak (4), Huai Khwang (17), Pom Prap Sattru Phai (8), Phra Nakhon (1), Bangkok Yai (16), Thon Buri (15), Bang Sue (29), Bang Kho Laem (31), Phaya Thai (14), Rajathewi (37), Yan Nawa (12), Khlong San (18), Sathon (28), Bangkok Noi (20), Wattana (39), Pathum Wan (7), Chatuchak (30), Khlong Toei (33), Din Daeng (26) and Dusit (2).

The middle region, is composed of 18 districts, i.e., Sa Phan Sung (44), Bang Na (47), Phasi Charoen (22), Suan Luang (34), Pra Khanong (9), Rat Burana (24), Khan Na Yao (43), Chom Thong (35), Prawet (32), Bang Khen (5), Wang Thong Lang (45), Lat Phrao (38), Bang Phlat (25), Bung Kum (27), Don Muang (36), Sai Mai (42), Bangkapi (6) and Lak Si (41).

The outer region, is composed of 11 districts, i.e., Nong Chok (3), Min Buri (10), Khlong Sam Wa (46), Latkrabung (11), Nong Kham (23), Bang Khun Thian (21), Thawi Watthana (48), Bang Bon (50), Bang Khae (40), Thung Khru (49) and Thaling Chan (19)[8].

There are several fresh food markets in one district. Thus, 133 fresh food markets in 40 districts of Bangkok (14 districts in the inner region, 17 districts in the middle region, and 9 districts in the outer region) were chosen as the representative markets (Fig. 1). The percentage of collection site per total area of inner,

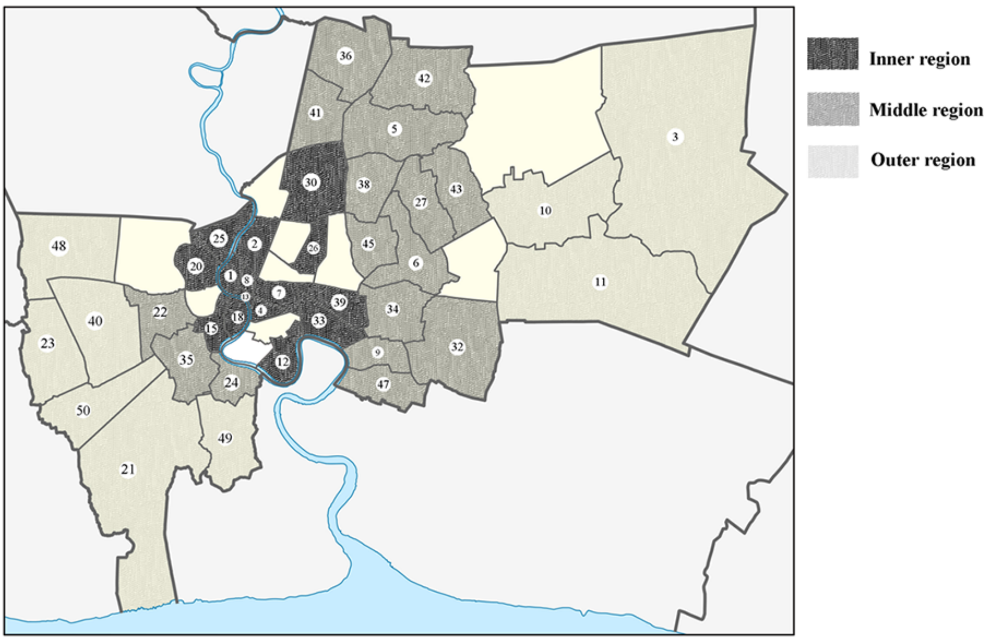

Fig. 1 The 40 districts of Bangkok which were chosen as the collection sites. The number in circle represents the districts shown in Table 1.

Table 1. Abundance of trapped rodents species and fleas (n) and total flea index value of each districts of 3 different geographical regions in Bangkok

Area	District Name/No.	Number of trapped rodents and fleas (n)/ species of rats and shrews								Total number (n)		Total flea index
		Rattus norvegicus		*Rattus rattus*		*Rattus exulans*		*Suncus murinus*				
		Rat	Flea	Rat	Flea	Rat	Flea	Shrew	Flea	Rat	Flea	
Inner	Phra Nakhon (1)	7	24	4	5	5	15	4	6	20	50	2.50
	Dusit (2)	16	30	11	7	3	2	2	0	32	39	1.22
	Bang Rak (4)	2	2	0	0	0	0	1	0	3	2	0.67
	Pathum Wan (7)	0	0	0	0	0	0	0	0	0	0	-
	Pom Prap Sattru Phai (8)	4	0	0	0	1	0	0	0	5	0	0.00
	Yan Nawa (12)	2	0	0	0	4	1	1	0	7	1	0.14
	Sampantawong (13)	17	1	0	0	0	0	4	0	21	1	0.05
	Thon Buri (15)	6	0	2	10	3	2	6	5	17	17	1.00
	Khlong San (18)	4	0	0	0	0	0	0	0	4	0	0.00
	Bangkok Noi (20)	6	1	4	0	4	2	2	0	16	3	0.19
	Din Daeng (26)	3	1	0	0	0	0	1	0	4	1	0.25
	Chatuchak (30)	12	11	0	0	0	0	0	0	12	11	0.92
	Khlong Toei (33)	5	0	0	0	3	4	0	0	8	4	0.50
	Watthana (39)	3	13	0	0	2	2	9	7	14	22	1.57
	Total	87	83	21	22	25	28	30	18	163	151	0.93
Middle	Bang Khen (5)	0	0	0	0	0	0	0	0	0	0	-
	Bang Kapi (6)	14	33	0	0	7	27	0	0	21	60	2.86
	Pra Khanong (9)	0	0	1	1	2	2	0	0	3	3	1.00
	Phasi Charoen (22)	1	0	0	0	3	1	0	0	4	1	0.25
	Rat Burana (24)	3	0	0	0	0	0	0	0	3	0	0.00
	Bang Phlat (25)	9	11	0	0	7	11	2	0	18	22	1.22
	Bung Kum (27)	3	4	0	0	8	25	0	0	11	29	2.64
	Prawet (32)	3	0	0	0	0	0	0	0	3	0	0.00
	Suan Luang (34)	1	0	1	2	0	0	4	0	6	2	0.33
	Chom Thong (35)	1	1	2	10	1	1	0	0	4	12	3.00
	Don Muang (36)	4	0	2	1	1	0	0	0	7	1	0.14
	Lat Phrao (38)	0	0	0	0	1	0	0	0	1	0	0.00
	Lak Si (41)	0	0	0	0	1	5	0	0	1	5	5.00
	Sai Mai (42)	4	2	0	0	3	0	0	0	7	2	0.29
	Khan Na Yao (43)	4	1	0	0	0	0	0	0	4	1	0.25
	Wang Thong Lang (45)	6	0	0	0	0	0	0	0	6	0	0.00
	Bang Na (47)	2	1	2	1	3	7	0	0	7	9	1.29
	Total	55	53	8	15	37	79	6	0	106	147	1.39
Outer	Nong Chok (3)	1	0	0	0	1	1	0	0	2	1	0.50
	Min Buri (10)	5	10	0	0	2	15	0	0	7	25	3.57
	Latkrabung (11)	3	0	0	0	1	0	0	0	4	0	0.00
	Bang Khun Thian (21)	3	0	0	0	1	0	0	0	4	0	0.00
	Nong Kham (23)	4	0	0	0	1	0	2	0	7	0	0.00
	Bang Khae (40)	23	27	0	0	2	0	0	0	25	27	1.08
	Thawi Watthana (48)	1	2	0	0	2	2	0	0	3	4	1.33
	Thung Khru (49)	2	0	0	0	0	0	0	0	2	0	0.00
	Bang Bon (50)	0	0	0	0	0	0	0	0	0	0	-
	Total	42	39	0	0	10	18	2	0	54	57	1.06

- = Flea index is not available due to no trapped rodents middle and outer regions were: 66.67, 94.44, and 81.82%, respectively. The collection sites (districts) and the number of trapped rodents and fleas were shown in Table 1.

Rodents trapping and flea collection

Small rodents, rats, and shrews, were trapped by using cage mouse traps. This trap could be set in several locations by a single collector which baited with dried squids or fish balls and randomly placed them overnight in habitats deemed suitable for the passage of the rodents. Traps were checked as early in the morning or at 24 hours after setting. The collected host traps were placed in plastic bags or other closed container with cotton balls soaked with ethyl ether until the host became unconscious[9]. Host was removed from bag while the bag was examined for parasites left from the host body. The body of each animal was searched by back-combing the fur above a white tray containing water until ectoparasites ceased to appear. The ectoparasites were removed with fine-tipped forceps. Ears, nostrils, mouth, and other body openings of the host were examined under a stereomicroscope for fleas that may have entered in an attempt to escape the fumigant and exposed parts of the host. Feet and tail were also examined for fleas that may be attached by their mouthparts or embedded in the host tissues[10-12].

Rodent and flea identification

Rodent species identification was done by morphological character following to Marshall (1988)[13] and Aplin et al (2003)[14]. Flea specimens were prepared and the important characteristics observed under a stereomicroscope to identify by keys of Robert E Lewis (1993)[10].

Data analysis

Shannon-Wiener diversity index (H) was used to analyse species diversity among 133 fresh food markets in 40 districts of Bangkok, $H = -\sum_{i=1} (\Pi \ln (\Pi))$

This index accounts both abundance and richness of the species present. The proportion of species i relative to the total number of species (II) is calculated and then multiplied by the natural logarithm of this proportion (LnII). The result is summed across species and multiplied by -1[15].

Percentage of trap success was calculated from number of individuals captured divided by the total effort (number of cages), multiplied by 100[16]. This index accounts the density of reservoir hosts.

$$\text{Percent trap success} = \frac{\text{Total amount of trapped rodents}}{\text{Number of cages/days of trapping}} \times 100$$

The most basic information obtained from flea and rodent surveys is the number of fleas of different species found on various species of hosts. This raw data can be used to calculate various indices, including:

$$\text{Total flea index} = \frac{\text{Total number of fleas collected from the rat examined}}{\text{Total No. of rat examined}}$$

$$\text{Specific flea index} = \frac{\text{Number of fleas of species X collected from host species Z}}{\text{Number of individuals of host species Z examined}}$$

The number of rats and fleas of each sample sites were used to calculate the total flea index and specific flea index and continue calculated for report in pattern $\bar{x} \pm SE;\ SE = \frac{s}{\sqrt{n}}$, where *s* is the sample standard deviation n is the size (number of observations) of the sample.

Results

A total of 323 rats and shrews were captured from 133 fresh food markets in 40 districts of Bangkok. The collected animals comprised 3 rat species (*Rattus norvegicus*, *R. exulans*, and *R. rattus*), and 1 shrew species (*Suncus murinus*). The most abundant species was *Rattus norvegicus* (56.97%) followed by *R. exulans* (22.29%), *Suncus murinus* (11.76%), and *R. rattus* (8.98%).

The highest species diversity of rats and shrews appeared in Phra Nakorn (H = 1.36) followed by Bangkok Noi (H = 1.32) and Thon Buri district (H = 1.29). H-index will increase when the numbers are rising and the distribution of each species is consistent. H is equal to 0 when there is only one type in the dataset. However, in practice, the H-index is smaller than 5. These results imply that Phra Nakorn had a great number of species present (Fig. 2).

The mean percentages of trap success rates of the inner, middle and outer regions were 20.63, 16.82 and 21.69%, respectively. The highest percentage of trap success was 70, which appeared in Min Buri district (Table 2).

A total of 355 flea samples were collected from rats and shrews trapped from these fresh food markets. All of them were *Xenopsylla cheopis*. The most abundant flea (33 samples) was founded in *Rattus norvegicus* collected from Ram 24 market in Bangkapi district. The average total flea index value of 133 fresh food markets was 1.10$\pm$0.20 and the highest flea index (5.40) was founded in Ram 24 market in Bangkapi district. The comparison of average total flea index value of each district in Bangkok is shown in Fig. 3. The

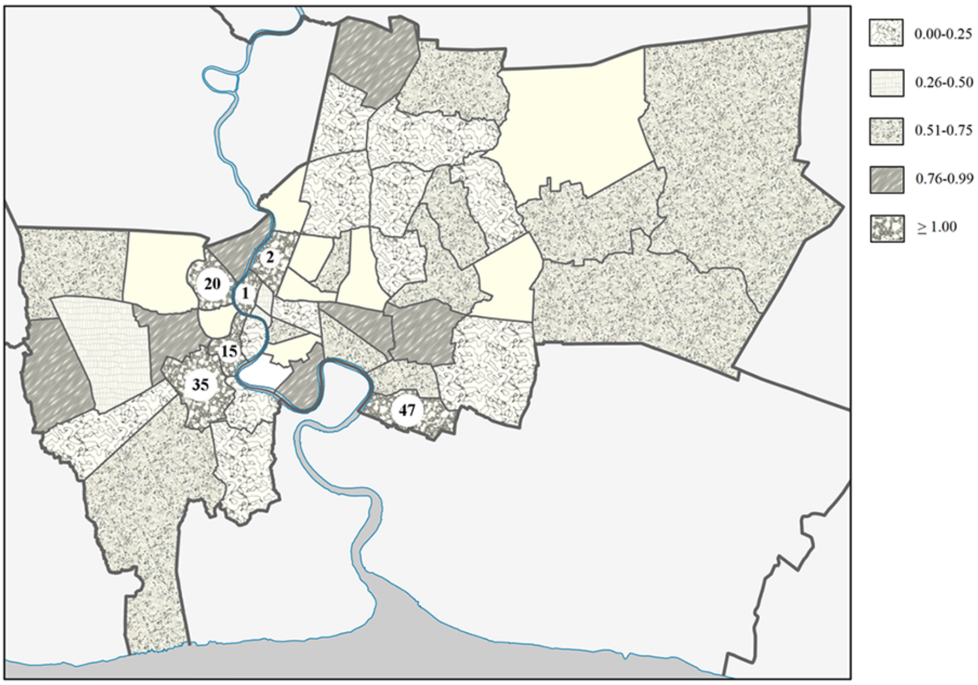

Fig. 2 Species diversity of rats and shrews in fresh food markets in 40 districts of Bangkok (Shannon-Wiener diversity index; H): (1) Phra Nakhon, (2) Dusit, (15) Thon Buri, (20), Bangkok Noi, (35) Chom Thong, (47) Bang Na.

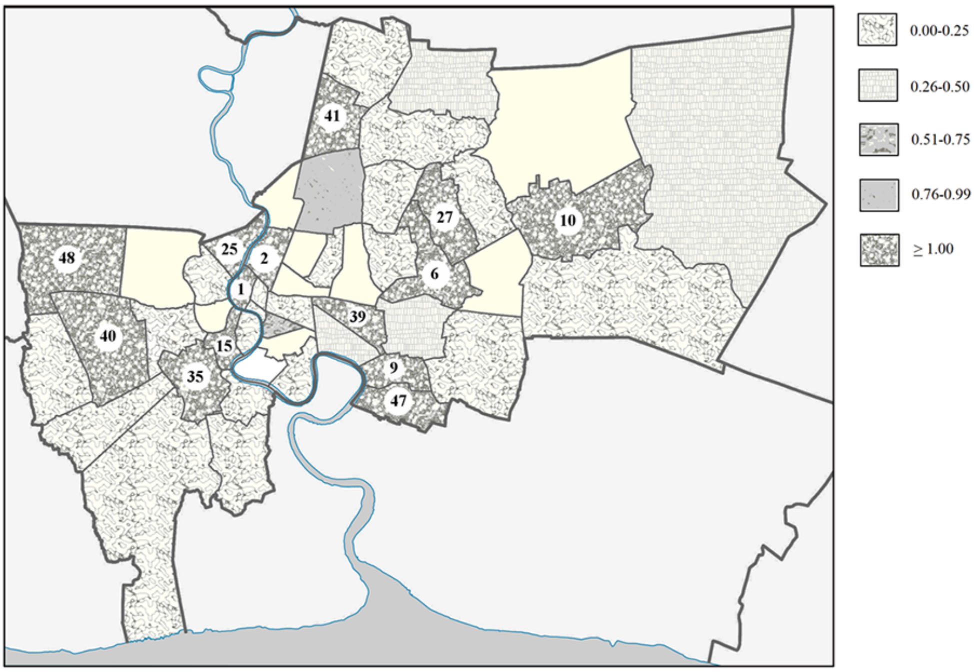

Fig. 3 The comparison of average total flea index value of each district in Bangkok: (1) Phra Nakhon, (2) Dusit, (6) Bang Kapi, (9) Pra Khanong, (10) Min Buri, **(**15) Thon Buri, (25) Bang Plat, (27) Bung Kum, (35) Chom Thong, (39) Watthana, **(**40) Bang Khae, (41) Lak Si, (47) Bang Na, (48) Thawi Watthana.

Table 2. Specific flea index, total flea index and % trap success of 3 different geographical regions in Bangkok

Geographical regions	Specific flea index* of each animal species				Total flea index*	% trap success		
	Rattus norvegicus	*Rattus rattus*	*Rattus exulans*	*Suncus murinus*		Max	Min	Average
Inner	0.95±0.40	1.05±1.12	1.12±0.31	0.60±0.20	0.93±0.21	46.67	0	20.63
Middle	0.96±0.20	1.88±0.85	2.14±0.52	0	1.39±0.36	40.0	0	16.82
Outer	0.93±0.33	0	1.80±1.04	0	1.06±0.44	70.0	8.0	21.69
Overall	0.95±0.18	1.28±0.64	1.74±0.36	0.47±0.14	1.10±0.20	70.0	0	19.71

* Flea index value = $\bar{x} \pm$ SE, n value is shown in Table 1

comparison of specific flea index value of each species of rat and shrew and total flea index of fresh food markets is shown in Table 2 which demonstrated *Rattus exulans* was the rat species that given the highest specific flea index (1.74±0.36).

Discussion

Rodents are important reservoirs of zoonotic agents hosting a wide range of bacteria, protozoa, and viruses of medical and veterinary importance. These pathogens can be transmitted either directly via exposure to rodent excreta or indirectly via arthropod vectors such as fleas, lice, mites, and ticks[17]. Rodents propagate pathogen cycles both by being a source of infection for the vectors and by supporting vector populations themselves. Knowledge of specific host–ectoparasite associations in an area can provide important insights into the disease transmission[12].

Rat and mice in Thailand are divided into commensal and field animals by their natural habitats. The majority of commensal rats and mice previously found in Thailand are *Rattus norvegicus R. exulans R. rattus*, and *Mus musculus*[18]. In our study, the most abundant species of rats and shrews in fresh food markets in 40 district of Bangkok was *Rattus norvegicus* (56.97%) followed by *R. exulans* (22.29%), *Suncus murinus* (11.76%), and *R. rattus* (8.98%). Our results are consistent with a previous study showing that *Rattus norvegicus* was the predominant rat species of fresh food markets in Bangkok[8,19]. Moreover, there were 3 previous studies on rodent trapping in Bangkok, the first one by Yabe et al (1989)[20], the second one by Imvithaya et al (1997)[21] and the third one also by Imvithaya et al (1998)[22]. Those studies reported that *R. exulans* was the most common rodents captured. The difference could be explained by location of trapping[8,19] and bait[19], but not by the method of trapping which were the same[8,19].

The highest number of rodents captured (32) was founded in Dusit district. In contrast to previous study[8] which founded that number of animals captured was highest in Bangkapi district (the second rank of higher number of captured animals in our study). Thus, we conclude that Bangkapi district has been the best habitats for rodents in Bangkok for long time.

The highest density of reservoir host was found in the inner region. Percentage of trap success of almost all district in this area was high. Although the outer region showed higher average % trap success, it because of unusually value of one district which come from the survey in only one market (data not shown).

There are differences in the layout of the interior spaces, the opening time and the sanitary managements of each market. These factors may affect in the percentage of trap success. The study of these data such as the market interior structures and choosing a suitable trapping time should be studied to improve the trapping methods in the further researches.

The highest species diversity of rats and shrews appeared in Phra Nakorn (H = 1.36) followed by Bangkok Noi (H = 1.32), Thon Buri (H = 1.29) and Dusit district (1.11), respectively. All of 4 districts showing high species diversity are located adjacent rim of Chao Phraya River (Fig. 2) and placed in the inner region of Bangkok (Fig. 1). In addition to the mean annual rainfall and temperature which were positively correlated with the density of reservoir hosts[19]. Our observations imply that the geographic characteristics affect the species diversity of rats and shrews and the density of reservoir hosts.

The flea abundance represented as total flea index of each region of Bangkok was calculated from the amount of fleas which collect from rodent hosts (Table 1 and 2). The inner region shows significantly results. Although the total flea index of this region is lower than the other, we were able collect flea from every species of host with high value which is evident from specific flea index (Table 2). The specific flea index is the most widely used of the indices. It can be used in conjunction with other rodent and vector surveillance data to estimate human and epizootic risks. For example, it has been reported that a specific flea index of greater than 1 for *X. cheopis* on rats represents a potentially dangerous situation with respect to an increased plague risk for humans[7] and an outbreak can occur if the specific flea index is higher than 5[8]. Considering the data that shown more diversity of hosts and vectors, we conclude that there is more chance of the disease spreading in this region. Moreover, the data shown that we were able to collect fleas from *R. norvegicus* and *R. exulans* in all regions (Table 1 and 2). These implied that *R. norvegicus* and *R. exulans* were the achievable hosts of oriental rat flea in Bangkok.

The most abundant of oriental rat flea, *Xenopsylla cheopis*, (54 samples) was found in rats (33 samples were collected from *Rattus norvegicus*) which were collected from Ram 24 market in Bangkapi district. This data caused the highest total flea index (5.40) and average total flea index (2.86) as the followed results (Fig. 3). This result may be related to density of population and number of houses in this district. Bang Kapi consists of 84,989 households with the density of population estimated at 5,265 individuals/km^2[23]. The number of houses in Bangkapi district is at the second rank among 50 districts of Bangkok but the density of population is higher while the total region is less than the first rank district (Bang Khen). It shows that Bangkapi is a region with high residential density. These conditions may be an appropriate factor for *R. norvegicus* to multiply. It occurs in many major cities and towns, where rats live in and around buildings, feeding on refuse and stored food[24]. However, our results differ from a previous study which showed that the most abundant fleas (59 samples) were found in the market of Pom Prap Sattru Phai[8].

Phra Nakorn was another district that showed high total flea index (5.25) in Pak Khlong Talat market and average total flea index of this district was 2.50. Moreover, Phra Nakorn had a great number of rats and shrews species present (H = 1.36). Although Phra Nakorn flea index value seem to be lower than that of Bangkapi, our finding could be interpreted as this district having a larger flea index distribution because we found fleas in every collection site (market) while we found fleas in only 2 from all 8 collections in Bangkapi. All of our results implied that Phra Nakhon district is also a region with high potential for spreading the disease caused by rat and fleas. Phra Nakorn consists of 18,457 households with the density of population estimated at 11,086 individuals/km^2[23]. Compared with the number of houses, the density of population of this district is very high. Phra Nakhon is located adjacent to the rim of the Chao Phraya River (Fig. 2). There are conservation regions, historical, and cultural sights and political dominance of the capital located in this district. These conditions may be the appropriate factors for rats and shrews biology. *R. norvegicus* is often found close to water, such as along rivers and major irrigation canals[14].

Another noticeable district is Bueng Kum. This district showed high total flea index (4.0) in Intrarak market and average total flea index of this district was 2.64. Bueng Kum consists of 60,895 households with the density of population estimated at 6,076 individuals/km^2[23]. Although general condition of Bueng Kum is low residential density, western regions of this district was closely connected with Bangkapi (the district that showed the highest flea index). So migration of rats and fleas between 2 districts could have occurred.

Lak Si and Min Buri were other districts that showed high average total flea index (5.0 and 3.57, respectively) which higher than 3 districts mentioned above. This data come from the survey of only one market. So it could not be representative data to be interpreted.

Overall considering all 40 districts survey, there are 13 districts showed total flea index $\geq$1 and 15 districts showed total flea index = 0. The high risk region for plague occurrence in fresh food market of Bangkok was 32.5% of overall area.

Among the diseases that transmitted by fleas, plague is a highly virulent disease believed to have killed millions during three historic human pandemics and still re-emerged in present[24]. From our finding, average total flea index for all over Bangkok was 1.10$\pm$ 0.20. Our result is inconsistent with a previous study which showing that total flea index for all over Bangkok was 0.65[8]. The difference is very important because a specific flea index of greater than 1 for *X. cheopis* on rats represents a potentially dangerous situation with respect to increased plague risk for humans[7].

Conclusion

Regarding the geographical factors, we could not conclude that there is no risk of plague at all. If *Yersinia pestis*, etiological agent of plague, is introduced to Thailand, the inner region of Bangkok (Phra Nakorn, Bangkok Noi, Thon Buri and Dusit district) and the middle region (Bangkapi and Bueng Kum) will be at high risk for disease transmission because of its high species diversity and density of rodents and its high flea index values. Flea index can be used in conjunction with other rodent and vector surveillance data to estimate human and epizootic risks.

What is already known on this topic?

The majority of commensal rodents previously found in Bangkok were different depending on location of trapping. The density of reservoir hosts and the total flea index were positively correlated with the mean annual rainfall and temperature.

What this study adds?

Our data suggested that *Rattus norvegicus* was the predominant rat species of fresh food markets in Bangkok. The geographic characteristics which affected the species diversity of rats and shrews and the density of reservoir hosts have been investigated in this study.

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Potential conflicts of interest

None.

References

1. Gratz N. Rodent reserviors & flea vectors of natural foci of plague. In: Dennis DT, Gage KL, Gratz NG, Poland JD, Tikhomirov E, editors. Plague manual: epidemiology, distribution, surveillance and control. Geneva: WHO; 1999: 63-96.
2. Eisen RJ, Gage KL. Transmission of flea-borne zoonotic agents. Annu Rev Entomol 2012; 57: 61-82.
3. Bin Saeed AA, Al Hamdan NA, Fontaine RE. Plague from eating raw camel liver. Emerg Infect Dis 2005; 11: 1456-7.
4. Joshi K, Thakur JS, Kumar R, Singh AJ, Ray P, Jain S, et al. Epidemiological features of pneumonic plague outbreak in Himachal Pradesh, India. Trans R Soc Trop Med Hyg 2009; 103: 455-60.
5. Pham HV, Dang DT, Tran Minh NN, Nguyen ND, Nguyen TV. Correlates of environmental factors and human plague: an ecological study in Vietnam. Int J Epidemiol 2009; 38: 1634-41.
6. Baxter JD. The typhus group. Clin Dermatol 1996; 14: 271-8.
7. Gage KL. Plague surveillance. In: Dennis DT, Gage KL, Gratz NG, Poland JD, Tikhomirov E, editors. Plague manual: epidemiology, distribution, surveillance and control. Geneva: WHO; 1999: 135-65.
8. Singchai C, Deesin V, Srisawat R, Yamput S, Phanphuwong T, Pongwatanakulsiri P, et al. Surveillance of commensal rat and shrew populations in the Bangkok area with references to flea index as the risk indicator of plague. J Med Assoc Thai 2003; 86: 795-801.
9. de Moraes LB, Bossi DE, Linhares AX. Siphonaptera parasites of wild rodents and marsupials trapped in three mountain ranges of the Atlantic forest in southeastern Brazil. Mem Inst Oswaldo Cruz 2003; 98: 1071-6.
10. Lewis RE. Siphonaptera. In: Lane RP, Crosskey RW, editors. Medical insects and arachnids.

London: Chapman & Hall; 1993: 529-75.
11. Shayan A, Rafinejad J. Arthropod parasites of rodents in Khorram Abbad district, Lorestan Provincen of Iran. Iranian J Publ Health 2006; 35: 70-6.
12. Harrison A, Robb GN, Alagaili AN, Hastriter MW, Apanaskevich DA, Ueckermann EA, et al. Ectoparasite fauna of rodents collected from two wildlife research centres in Saudi Arabia with discussion on the implications for disease transmission. Acta Trop 2015; 147: 1-5.
13. Marshall JT. Family muridae: rats and mice. In: Lekagul B, McNeely JA, editors. Mammals of Thailand. 2nd ed. Bangkok: Association for the Conservation of Wildlife; 1988: 397-487.
14. Aplin KP, Brown PR, Jacob J, Krebs C, Singleton GR. Field methods for rodent studies in Asia and the Indo-Pacific. Canberra: ACIAR Monograph; 2003.
15. Smith EP. Ecological statistics. In: El-Shaarawi AH, Piegorsch WW, editors. Encyclopedia of environmetrics. Chichester: John Wiley & Sons; 2002: 589-602.
16. Caceres NC, Napoli RP, Hannibal W. Differential trapping success for small mammals using pitfall and standard cage traps in a woodland savannah region of southwestern Brazil. Mammalia 2011; 75: 45-52.
17. Meerburg BG, Singleton GR, Kijlstra A. Rodent-borne diseases and their risks for public health. Crit Rev Microbiol 2009; 35: 221-70.
18. Marshall JT, Pantuwatana S. Identification of rats of Thailand. Bangkok: Applied Scientific Research Corporation of Thailand; 1966.
19. Chotelersak K, Apiwathnasorn C, Sungvornyothin S, Panasoponkul C, Samung Y, Ruangsittichai J. Correlation of host specificity, environmental factors and oriental rat flea abundance. Southeast Asian J Trop Med Public Health 2015; 46: 198-206.
20. Yabe T, Chenchittikul M. Predominant species of commensal rats in rural areas Thailand. Jpn J Sanit Zool 1989; 40: 345-7.
21. Imvithaya A, Phan-urai P, Phaeporn P. Distribution of rats' ectoparasites in Bangkok and Nonthaburi. J Health Sci 1997; 6: 650-5.
22. Imvithaya A, Warachit P, Naigowit P, Chuprapawan C. Surveillance of plague in the province along Thai border. Ministry of Public Health Journal 1998; 17: 97-106.
23. Bureau of Registration Administration, Department of Provincial Administration, Ministry of Interior. Area, population, density and houses in Bangkok Metropolis by Districts [Internet]. 2009 [cited 2013 Jul 23]. Available from: http://203.155.220.230/info/stat_search/stat_10/stat10_01.htm.
24. Stenseth NC, Atshabar BB, Begon M, Belmain SR, Bertherat E, Carniel E, et al. Plague: past, present, and future. PLoS Med 2008; 5: e3.

ความสัมพันธ์ระหว่างปริมาณของหมัดหนูเมืองร้อนและสัตว์ฟันแทะในเขตภูมิศาสตร์ที่แตกต่างกันของกรุงเทพมหานคร

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ภูมิหลัง: *หมัดมีบทบาทสำคัญในการเป็นพาหะของโรคติดต่อและโรคติดเชื้ออุบัติซ้ำ ในบรรดาโรคเหล่านี้กาฬโรคเป็นโรคที่มีความรุนแรงสูง ซึ่งสามารถแพร่ระบาดโดยหมัดหนูเมืองร้อนหรือ Xenopsylla cheopis เป็นพาหะ การเฝ้าระวังโรคโดยการสำรวจปริมาณหนูและหมัดแล้วนำมาคำนวนค่า "ดัชนีหมัดหนู" ใช้เป็นตัวบ่งชี้อัตราเสี่ยงของการเกิดกาฬโรคได้*

วัตถุประสงค์: *เพื่อศึกษาการกระจายตัวของสัตว์ฟันแทะและหมัดหนูเมืองร้อน และศึกษาความสัมพันธ์ระหว่างความอุดมสมบูรณ์ของสัตว์ฟันแทะและหมัดหนูเมืองร้อนกับพื้นที่ทางภูมิศาสตร์ในกรุงเทพมหานคร*

วัสดุและวิธีการ: *ทำการวางกรงดักจับสัตว์ฟันแทะขนาดเล็กในบริเวณตลาดสดที่ตั้งอยู่ใน 3 เขตภูมิศาสตร์ที่แตกต่างกันของกรุงเทพมหานคร ในช่วงเดือนสิงหาคม พ.ศ. 2552 และเก็บหมัดจากสัตว์ฟันแทะโดยการแปรงย้อนขนสัตว์แต่ละตัวที่จับได้ นำผลที่ได้มาคำนวนค่าดัชนีหมัดรวม (total flea index) ค่าดัชนีหมัดจำเพาะ (specific flea index) ค่า Shannon-Wiener diversity index และค่า percentage of trap success เพื่อใช้วิเคราะห์ข้อมูล*

ผลการศึกษา: *จากข้อมูลที่ได้พบว่าค่าเฉลี่ยของดัชนีหมัดรวมในพื้นที่ชั้นใน ชั้นกลาง และชั้นนอกของกรุงเทพมหานครมีค่าเท่ากับ 0.93±0.21, 1.39±0.36 และ 1.06±0.44 ตามลำดับ และค่าดัชนีหมัดจำเพาะของโฮสต์สัตว์ฟันแทะ Rattus norvegicus, Rattus rattus, Rattus exulans และ Suncus murinus มีค่าเท่ากับ 0.95±0.18, 1.28±0.64, 1.74±0.36 และ 0.47±0.14 ตามลำดับ ซึ่งปริมาณของหมัดที่เก็บรวบรวมได้มีความสัมพันธ์เชิงบวกกับความแตกต่างทางภูมิศาสตร์ของแต่ละพื้นที่ นอกจากนี้ยังพบว่ามีความหลากหลายของชนิดของหนูและหนูผีมากที่สุดในพื้นที่ชั้นในของกรุงเทพมหานครและมีค่า Percentage of trap success ซึ่งเป็นค่าบ่งชี้ความหนาแน่นของโฮสต์กักเก็บเชื้อของพื้นที่ชั้นใน ชั้นกลาง และชั้นนอกเท่ากับ 20.63, 16.82 และ 21.69% ตามลำดับ โดยมีหนูท่อ (R. norvegicus) และ หนูจี๊ด (R. exulans) เป็นโฮสต์ที่สามารถติดเชื้อได้ของหมัดหนูเมืองร้อน*

สรุป: *จากผลการศึกษาดังกล่าวแสดงให้เห็นว่าพื้นที่ชั้นในของกรุงเทพมหานครเป็นบริเวณอันดับแรกที่ควรทำการปรับปรุงสุขาภิบาลเพื่อป้องกันการแพร่กระจายของโรค*