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Ectoparasite fauna of rodents and shrews from four habitats in Kuala Lumpur and the states of Selangor and Negeri Sembilan, Malaysia and its public health significance

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Abstract. A total of 204 rodents comprising 14 host species from four different habitats were examined. Nine rodent species were trapped from the forest and another five species were trapped from the coastal, rice field and urban habitats. *Rattus rattus diardii* (67%) was the predominant rodent species examined. Fifty six (47.3%) rodents and shrews were found to be infested with at least one of the 20 species of ectoparasite recovered. Mites belonging to the family Trombiculidae were the predominant ectoparasite species recovered. Ticks belonging to the family Ixodidae were recovered mainly from the forest dwelling rodents. *Polyplax spinulosa* and *Hoplopleura pacifica* were the common lice species found infesting the urban rodents. *Xenopsylla cheopis* was the only flea species recovered. The following ecto-parasites have been incriminated as important vectors or as mechanical carriers for the transmission of zoonotic diseases: *Ixodes granulatus*, *Dermacentor* sp. *Haemaphysalis* sp., *Amblyomma sp. Ascoschoengastia indica*, *Leptotrombidium deliense*, *Ornithonyssus bacoti*, *Laelaps nuttalli*, *H. pacifica*, *P. spinulosa* and *Xenopsylla cheopis*. Urban and forest rodents were significantly higher in ecto-parasitic infestation, compared to rats from the other two habitats. However, there was no significant statistical association between male and female rodents infested with ectoparasites.

INTRODUCTION

Rodents especially those that live in close proximity with humans (synanthropic rodents) play a significant role in the transmission of diseases to humans and animals while others act as reservoir host. These rodents also play a significant role as pests in the agricultural and urban environment causing economic losses (Walsh *et al.*, 1993; Mayer *et al.*, 1995; Singleton *et al.*, 2003).

The arthropod ectoparasites of rodents are important vectors of pathogenic microorganisms and for parasitic zoonoses like babesiosis (Singleton *et al.*, 2003), plague and others. Ectoparasites recovered from rodents are classified into five main groups, Mesostigmata (mites), Prostigmata (chiggers), Acarina (ticks), Phthiraptera (louse) and Siphonaptera (fleas).

In Malaysia, several studies identifying the rodent host and its arthropod ecto-parasites have been conducted (Audy, 1957; Kohls, 1957; Nadchatram *et al.*, 1966; Lim, 1972; Zahedi *et al.*, 1984; Ho *et al.*, 1985; Ho & Krishnasamy, 1991; Shabrina, 1990; Mariana *et al.*, 1996; Salleh *et al.*, 2003; Chulan *et al.*, 2005). However, no comprehensive studies has been conducted thus far to compare the prevalence of ectoparasites in different rodent habitats. This study was conducted to determine the species distribution of ectoparasites and

compare the infestation rate in four different habitats and their zoonotic implications.

MATERIALS AND METHODS

Trapping locations

Trapping of rodents was conducted in the four habitats from 2004 to 2006. The habitats were, forest, ricefield, coastal, and urban (wet markets). Fruits, coconuts, dried fish and sweet potatoes were used as baits. Urban rodents were trapped from the following wet markets: Chow Kit, Dato Keramat, Setapak, Jinjang and Kepong in Selangor and Kuala Lumpur. Forest rodents were trapped from the Gombak Forest Reserve in Selangor which is situated about 21 kilometres away from Kuala Lumpur. Rice field rodents were trapped at Tanjung Tualang, Selangor paddy fields. The coastal rats were trapped along the beaches at Port Dickson, Negeri Sembilan (Figure 1).

Trapping

All rodents were trapped alive using specially made wire traps measuring 29x22x50cm. Trapped rodents were killed humanely by placing them in a cloth bag containing cotton wool soaked with chloroform. The killed animal was then tagged for identification.

Identification of rodent species

Keys and illustrations developed by Harrison & Quah (1962) and Medway (1983) were used to identify the rodent species by morphological measurements and physical appearances.

Examination of ecto-parasites

The fur of each anaesthetised rat was combed with a fine tooth comb to dislodge any ecto-parasite into an enamel tray. Fine forceps were used to remove ticks and mites from the skin of rats when it was difficult to dislodge them by combing. Each cloth bag where the rat was placed was inverted over the enamel tray to collect dislodged ecto-parasites. The contents of the enamel tray was examined carefully with a hand lens and any ectoparasites seen were recovered using the moistened end of a sharpened wooden applicator stick and placed in a collection tube containing 70% alcohol. A separate container was used for each animal.

Processing of ectoparasites

Mesostigmatid mites were removed from the alcohol and rinsed in water. They were next placed in lactophenol (a clearing agent) for up to 1 week at room temperature. Small punctures were made with minute pin in the lateral edges of larger specimens (fleas and ticks) to facilitate lactopehenol entry. Cleared specimens were washed once in distilled water and mounted in Hoyer's medium. Individual chiggers (larval trombiculid mites) were removed from the alcohol and placed directly in a drop of Hoyer's mounting medium on a glass slide. A cover slip was placed over the specimen. The slide was intermittently warmed in an open oven to facilitate clearing of the chiggers. At the same time occasional light pressure was exerted using a sharpened applicator stick on areas of the cover slip surrounding the specimen.

Listrophorid mites and lice were processed and mounted following the technique used for mesostigmatid mites. All mounted slides were incubated at 40°C for one week to harden the mounting medium. All the mesostigmatid mites, ticks and lice found were identified using available keys, published taxonomic drawings and reference manuals (Kohls, 1957; Drummond & Baker, 1960; Johnson, 1964; Nadchatram & Ramalingam, 1974). Listrophorid mites were not identified as taxonomic keys were not available.

Data analysis

The significance of individual factors (habitats and sex) as determinants for ectoparasite infestation was investigated by univariate Fisher Exact test and Chi-square analysis. The analysis was performed using SPSS (Statistics Package for Social Sciences) version 12.

Figure 1. Rodent trapping locations.

RESULTS AND DISCUSSION

A total of 20 different species of ectoparasites comprising five orders namely Mesostigmata (mites), Prostigmata (chiggers), Metastigmata (ticks), Phthiraptera (louse) and Siphonaptera (fleas) were recovered from rats from all the habitats (Tables 1 & 2). Mites (47.3%) were the predominant ectoparasite found on rats from all the four habitats followed by fleas (12.4%), lice (11.9%) and ticks (10.4%) (Table 3). Fifty six (57.7%) rodents were found to be infested with at least one species of ectoparasite.

Table 1. Ectoparasites recovered from wild (forest) rodents

Rodent Host	Mites	Chiggers	Ticks
Maxomys rajah	Listrophoridae *Laelaps sanguisugus* *Laelaps sculpturata* *Longolaelaps longulus* *Laelaps aingworthae*	*Gahrlepia fletcheri*	*Amblyomma sp.* *Dermacentor sp* *Ixodes granulatus* *Haemaphysalis*
Leopoldamys sabanus	*Laelaps aingworthae* *Listrophoridae*	*Walchiella oudemansi*	*Dermacentor sp* *Ixodes granulatus* *Haemaphysalis*
Sundamys mulleri	Listrophoridae *Laelaps sculpturata*	*Gahrlepia fletcheri*	*Dermacentor* sp. *Ixodes granulatus* *Haemaphysalis*
Rattus bowersi	Listrophoridae *Laelaps sculpturata* *Laelaps aingworthae*	–	*Dermacentor* sp. *Ixodes granulatus* *Haemaphysalis*
Maxomys whiteheadi	*Laelaps sculpturata* *Laelaps aingworthae*	–	–
Tupaia glis	*Laelaps sculpturata* *Laelaps aingworthae*	–	*Dermacentor* sp.
Lariscus insignis	–	–	*Ixodes granulatus*

Table 2. Ectoparasites recovered from three rat host species from urban, coastal and rice field habitats

Rat Host	Fleas	Lice	Mites	Chiggers	Ticks	Habitat
Rattus r. diardii	*Xenopsylla cheopis*	*Polyplax spinulosa* *Hoplopleura pacifica*	*Laelaps echidinus* *Laelaps nuttali*	*Ascoschoengastia indica*	Urban	Urban
			Ornithonyssus bacoti			Urban
			Noetodres muris			Urban
			Laelaps nuttali			Urban
				Leptotrombidium deliense		Coastal
				Walchiella oudemansi		Coastal
			Listrophoridae *Laelaps ecidininus*		*Amblyomma* sp.	Rice Field
Rattus novergicus	*Xenopsylla cheopis*	*Polyplax spinulosa*		*Ascoschoengastia indica*		Urban
Rattus exulans			*Laelaps nuttali*	*Ascoschoengastia indica*		Coastal

Table 3. Percentage of ectoparasite infestation in four habitats

Habitat	No. of rats examined (%)	No of rats +ve for lice (%)	No. of rats +ve for fleas (%)	No. of rats +ve for mites (%)	No. of rats +ve for ticks
Urban	97	16 (16.5)	23 (23.7)	56 (57.7)	0 (0%)
Forest	51	0	0	23 (45.1)	18 (35.3)
Rice Field	31	0	0	7 (2.6)	2 (6.45)
Coastal	22	8 (36.4)	2 (9.09)	9 (40.9)	1 (4.54)
Total	201	24 (11.9)	25 (12.4)	95 (47.3)	21 (10.4)

Note: Figures in parenthesis are in %
Figures in bold italics in parenthesis indicate overall percentage

Table 4. Flea (*Xenopsylla cheopis*) index for rodents for five urban locations

Locations	No of rats examined	No.of fleas collected	Flea index	Prevalence
Jinjang	17	3	0.18	18%
Kepong	20	6	0.3	30%
Setapak	20	11	0.55	55%
Chow Kit	21	3	0.14	14%
Dato Keramat	19	8	0.42	42%
Total	97	31	0.32	32%

There is significant difference between ectoparasite(ticks, mites and fleas) from the four habitats (Table 5). However, there was no association between sex of rodents to the infestation rate.

Urban habitat

Of the 97 urban rats examined for ectoparasites 57.7%, 23.7% and 16.5% were infested with mites, fleas and lice respectively. Interestingly, no ticks were found on urban rats sampled. Five groups of ectoparasites comprising 14 different species were recovered from three rodent hosts, namely, *Rattus rattus diardii*, *Rattus norvegicus* and *Rattus exulans* (Table 2). *Rattus r. diardii* is the predominant host species with the highest record of ectoparasite infestation. The cosmopolitan lice *Polyplax spinulosa* and *Hoplopleura pacifica* were the two common lice species recovered. They are considered to be of public health importance because these two rat lice are known to harbor plague bacilli and transmit tularemia and bartonellosis to humans and play an adjunctive role in the transmission of murine typhus and plague from rat to rat (Zahedi *et al.*, 1984). The absence of ticks on the rats sampled may be due to a vey low infestation rate or the environment is not suitable for tick survival. Findings of urban rodents especially *R.r. diardii* and *R. norvegicus* that were infested with ticks is rarely reported in the literature. However, Audy (1957) reported infestation of *R.r. diardii* with adult *Ixodes granulatus* and also the immature stages.

The Mesostigmatid mites *Laelaps nuttali and Laelaps echidinus* were found frequently on the rodents. The mites *Ornithonyssus bacoti* and *Noetodres muris* were not commonly found on the rats examined in the previous studies. *O. bacoti* is rarely found on Malaysian rats although it

Table 5. Distribution of ectoparasite based on habitat

		Habitats			
	Infestation	Coastal, Rice field & Forest n (%)	Urban n (%)	χ^2	p
Ticks	-ve	81 (78.6)	97 (100)	23.28	<0.001
	+ve	22 (21.4)	0 (0)		
Mites	-ve	64 (62.1)	41 (42.3)	7.91	<0.005
	+ve	39 (37.9)	56 (57.7)		
Lice	-ve	95 (92.2)	81 (83.5)	3.60	0.058
	+ve	8 (7.8)	16 (16.5)		
Flea	-ve	11 (97.1)	74 (76.3)	19.11	<0.001
	+ve	3 (2.9)	23 (23.7)		

has a worldwide distribution and has been incriminated to cause pruritic dermatitis in man. The first authentic case of dermatitis caused by *O. bacoti* in Malaysia was reported by Nadchatram & Ramalingam (1974).

Xenopsylla cheopis is the only flea species recovered from rats from this habitat. A total of 23 rats (23.7%) from all the five urban sites were found to be infested with fleas giving an overall flea index of 0.32 (Table 4). Statistical analysis indicates a strong relationship of flea infestation ($p<0.001$) among urban rats (Table 5). The prevalence of fleas in Setapak (55%) and Dato Keramat (42%) were slightly higher than Jinjang, Kepong and Chow Kit. This flea index may not reflect the true picture of flea infestation in the urban rat population because the rats were examined 24 hours after they were captured and during this time the fleas could have jumped off their host. Furthermore *X. cheopis* spend more time in the nest of their host than on the host itself (WHO Plague Manuel).

Fleas are the primary vectors of plague and also incriminated in the transmission of murine typhus. A good knowledge of local flea species and their host is essential for estimating risk of human plague infection and designing specific control measures. It has been reported that a specific flea index of greater than one for *X. cheopis* on rats represents a potentially dangerous situation with respect to increased plague risk for humans in the event of an outbreak of plague (WHO Plague Manual).

Forest habitat

Of the 11 species of rodents examined, six were found to harbour 11 different species of ectoparasites comprising of three groups namely Mesostigmata, Prostigmata and Metastigmata. Of the total of 51 rodents examined, 45.1% and 35.3% were infested with mites and ticks respectively (Table 3). There were no lice or fleas recovered from the forest rodents. However, a survey on ectoparasites of small mammals in the forest by Nadchatram *et al.* (1966), Ho & Krishnasamy (1991), Chulan *et al.* (2005) indicates that several species of rodents were infested with different genera of ticks, mites, chiggers and lice but no record of fleas isolated.

Maxomys rajah and *Leopoldaymys sabanus* and *Sundamys muelleri* are the predominant rodent hosts found to be infested by ectoparasites namely ticks, mites and chiggers. Among the Ixodidae recovered from rodents from this habitat is *Ixodes granulatus*, which was the predominant species followed by *Dermacentor* sp., *Haemaphysalis* sp. and *Amblyomma* sp. (Table 1). *Ixodes granalutus* was the

common tick found infesting five species of rodents including a shrew.

In Malaysia *I. granulatus* is the only species known to parasitise rats, squirrels and shrews in all active stages-larva, nymph and adults. *Ixodes granulatus* is medically important because the Russian spring–summer encephalitis virus has frequently been isolated from it (Nadchatram *et al.*, 1966). The genus *Ixodes* is also associated with many other tick borne zoonotic diseases in many parts of the world (Roberts & John, 2001; RatZooMan, 2006).

As for the chiggers, *Gahrlepia fletcheri* and *Walchiella oudemansi* were the two species recovered from the rodents *M. rajah* and *S. muelleri*. Salleh *et al.* (2003) did a similar study in the same habitat and reported a total of eight species of chiggers found on five species of rodents.

Seven species of rodents including a tree shrew were infested with at least one species of mesostigmatid mites. A total of four species of mesotigmatid mites belonging to a single family Laelapidae and one species belonging to the family Listrophoridae were recovered (Table 1). *Laelaps sculpturata*, *Laelaps aingworthae* were the predominant species followed by Listrophoridae *Maxomys rajah* harboured the most mesostigmatid mites compared to the other trapped rodents.

Salleh *et al.* (2003) reported isolating 5 species of mesotigmatid mites from rodents trapped from the same habitat and indicated *M. rajah* as having the most number of mite infestations. *Laelaps echidnus*, *Laelaps nuttalli*, *Laelaps insignis*, *Laelaps sedlaceki* and the chigger *Leptotrombidium deliense* were isolated from several rodent species including *M. rajah* and *Leopoldamys sabanus* in Salleh's study but in this study there were no isolation of these parasites from the rodents examined.

There were no flea or louse recovered from the rats captured in the Gombak Forest Reserve habitat which concurs with the study of Salleh *et al.* (2003). Ho *et al.* (1985, 1991) examined several species of forest rodents from Taman Negara (National Park) and they too failed to isolate any flea or lice. We speculate that the forest environment is not a suitable ecology for fleas and lice to survive.

Rice field habitat

A total of 31 rats comprising only of *R.r. diardii* were examined. The rats from this habitat were found to be infested with mites (22.6%) and ticks (6.45%). There were no louse or flea recovered (Table 3). Three different species of acari parasites were recovered from the rats (Table 1). The tick *Amblyomma* sp. found infesting *R.r. diardii* was a rare finding. The rats possibly picked up the infestation when they encountered their predators (pythons and snakes) which are commonly found in rice fields. Pythons and snakes are known to be infested with *Amblyomma*. The tick *Amblyomma* sp. has been reported to parasitise wild rodents such as *Niviventer rapit*, *L. sabanus* and *M. rajah surifer* but not on *R.r. diardii*. *Amblyomma* sp. tick has been reported to be generally found on wild reptiles such as lizards, snakes and water monitor lizards (Nadchatram *et al.* 1966).

Coastal habitat

Of the 22 rats examined from the coastal habitat four groups of ectoparasites were recovered (Table 2). Mites (40.9%) were the predominant ectoparasite followed by lice (36.4%) (Table 3). Two rats (9.1%) were found harboring the flea *X. cheopis* and a single *R.r. diardii* was found infested with the tick *Ambloyomma* sp. Nadchatram *et al.* (1966) reported recovering a female specimen of this species of tick from a log of wood near a beach.

The finding of the chigger on *R.r. diardii* along the beaches is of public health concern because *L. deliense* is an important vector for scrub typhus in the country (Ho & Krishnasamy, 1991, Nadchatram, 2008).

Of the total of 147 ectoparasites collected (ticks, n=15, fleas, n=31, lice, n=30 and mites, n=71), 20 different species were identified from rodents caught from the four habitats (Table 1 & 2). It was noticed that in terms of species diversity rodents caught from the urban habitat harbors a much larger number of ectoparasite species than the other three habitats. The ectoparasites that

are of medical importance are the mites *L. deliense*, *L. echidninus*, *L. nuttalli*, *O. bacoti*, the ticks *I. granulatus*, *Dermacentor sp*. and the flea, *X. cheopis*. Statistical analysis indicated a significant relationship between ectoparasite infestation and the habitats. The urban habitat tend to favour infestation of ectoparasites namely mites (χ^2=7.91, p<0.005) and fleas (χ^2=19.11, p<0.001), while the ticks are found to be closely associated to forest rodents (χ^2=23.28, p<0.001) (Table 5). The host (*R.r. diardii*) of the majority of the ectoparasites of medical importance were found in areas with human activities.

Most acarines that are vectors of zoonotic diseases are believed to have lived in close association with their animal hosts in a stable habitat such as the Gombak forest which has for a long time been in equilibrium with the climate and soil, undisturbed by humans (Nadchatram, 2008). Once this equilibrium is altered due to the pressure of human activities, there is a great danger of zoonotic viruses, bacteria, protozoa, parasites and fungi been transmitted to humans and their domesticated animals via these acarines. Worldwide approximately 12% of 50,000 or so known Acari live as various forms of parasites and of these less than 100 species are known to be of importance to medical and veterinary importance (Krantz, 1978). It must be stressed here that there are several reports of acari-borne zoonotic diseases been transmitted to humans causing serious medical complications including death in Malaysia (Nadchatram, 2008).

The rapid environmental degradation resulting in the current changes in the global climate may alter the ecology of rodents and create new foci that would promote the profiliration of vectors that will transmit rodent borne parasitic diseases. These ecological changes will increase contact between human and rodents resulting in a heavier disease burden that would challenge the efficiency of the public health services. The current data on ectoparasites of rodents in Malaysia lacks updating and this current study adds valuable data to draw appropriate conclusions for efficient control programmes to be put in place.

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