DISTRIBUTION AND MORPHOLOGICAL MEASUREMENTS OF WILD AND URBAN RODENTS FROM FOUR HABITATS IN THE STATES OF SELANGOR AND NEGERI SEMBILAN, MALAYSIA

PARAMASVARAN S.[1]*, SANI R.A.[2], KRISHNASAMY[1], AMAL N.M.[1], HASSAN L.[2], MOHD ZAIN S.N.[3], LATIFAH I.[1], RAHMAT M.S.[1], JOHN JEFFERY[4], SANTHANA R.L.[1] AND SELVANESAN S.[5]

1 Institute for Medical Research, Jalan Pahang, 50588 Kuala Lumpur, Malaysia.

2 Faculty of Veterinary Medicine, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia.

3 Institute of Biological Sciences, University of Malaya, 50603, Kuala Lumpur, Malaysia.

4 Department of Parasitology, Medical Faculty, University of Malaya, 50603, Kuala Lumpur, Malaysia.

5 Public Health Laboratory, Ministry of Health, Sungai Buloh, Selangor.

* Corresponding author: paramasvaran@imr.gov.my

ABSTRACT. A total of 204 rodents comprising of 14 species were identified from four different habitats namely urban, forest, paddy field and coastal. The Gombak forest reserve habitat was found to be ideal for the survival of 11 different rodent species. *Maxomys rajah, Leopoldamys sabanus* and *Sundamys muelleri* were the predominant rodent species distributed in the Gombak forest. *Rattus ratus diardii* was found mainly in the urban, paddy field and coastal habitat (67.1%). Morphological measurements of the rodents trapped from the four habitats did not show any major changes.

Keywords: Rodentia, Muridae, zoonotic, *Rattus ratus diardii*, habitats, morphological measurements, wild, urban

INTRODUCTION

The Order Rodentia are divided into three major groups: the Sciuromorpha (squirrel-shaped), Myomorpha (mouse-shaped) and Hystrichomorpha (porcupine-shaped). Commensal rats and mice are members of the rodent family Muridae which is part of the Myomorph group. Rodents belonging to the family Muridae are extremely successful and a dominant species in most regions of the world, largely due to their ability to adapt and then exploit new situations rapidly (Singleton *et al*., 2003).

Over the last 15 years, a general decrease in the rodent species diversity is said to have occurred in Peninsular Malaysia at the lower altitudes (below 5,000 ft). This is believed to be a direct result of human activities of deforestation and land development. However, some of these rodent species e.g. *Rattus tiomanicus,* have apparently adapted to the new conditions and seem to have thrived so as to become the predominant species (Lim, 1974a, 1974b).

The genus *Rattus* consists of nearly 200 sub-species that can be further grouped into 20 species in Malaysia. Most of the members of this genus are forest or island forms and the number of rodent

species that can be found in urban and agricultural habitats comprise of about 12 species (Roberts, 1977). In the tropical and subtropical countries, at least 20 species of rodents have been recognised as pests to agricultural crops. This includes *Rattus rattus diardii* and *Rattus norvegicus*, two of the most successful species that have adapted to all kinds environment and have become widespread in the world (Roberts, 1977).

In Malaysia, rodents particularly those belonging to the family Muridae, form the largest group of all mammals. It is also the group that has been well studied because of their effect on health and for economic reasons (Ow Yang, 1971). All Malayan rats are nocturnal (Medway, 1983). They form an important and diverse group in towns, on cultivated land and the forest, extending from the shore to mountain peaks and from ground level to the forest. Conventional baits with which rats can be trapped in Malaysia include tapioca root, sweet potato, oil palm nut, coconut flesh (preferable charred) and banana. In special circumstances, salted fish, peanut butter, fermented prawn paste ("belacan") and fruits such as jackfruit or durian seeds have also been used. Many different types of traps are available and effective. The most commonly used is the rectangular wire cage trap sold in many stores in the country.

Different species of rodents tend to be selective of their habitat, but when these habitats are destroyed or disturbed either through agricultural intensification, deforestation, or urbanization it can bring about changes in rodent species diversity (Walsh *et al*., 1993, RatZooMan, 2006). This invariably facilitates the emergence and transmission of rodent-borne zoonotic pathogens. Humans who come in contact with these rodent-borne pathogens directly (e.g. through rat bites) or indirectly (via ecto-parasites, or through contaminated food or water) are at risk of getting infected. The present study was conducted to identify the various rodent species inhabiting each of four different habitats, namely an urban, agricultural, coastal or forested environment, all of which that had been subjected to various kinds of agricultural and anthropogenic pressure over the years.

MATERIALS AND METHODS

Trapping Sites for Forest Rodents

Trapping of forest rodents using rectangular wire cages was carried out for eight continuous weeks between June to September 2005. One hundred live wire traps were placed in the forest valley along the river at the Ulu Gombak Forest Reserve (Figure 2), (3°15" N, 101°33" E) between 16th km to 21st km Bukit Tinggi, about 8 miles North East of Kuala Lumpur (Figure 1). The services of an Orang Asli who was familiar with the forest terrain was engaged to assist in the trapping and collection of the forest rodents. Trapping sites of rodents in the forest was between 2,000 ft. to 5,000 ft. above sea level. The

Note: Trapping sites are shown in rectangular boxes

Figure 1: Rodent trapping locations

traps were checked every day. Rodents found trapped were removed and the traps cleaned and replaced with fresh bait (Figure 3).

Trapping Sites for Urban Rodents

The trapping sites for urban rodents were in Jinjang (3°13″ N, 101°39″ E), Kepong (3°13″ N,101°37.6″ E), Setapak (3°11″ N, 101°42″ E), Chow Kit(3°10″ N, 101°42″ E) and Dato Keramat (3°10″ N, 101°43.5″ E) (Fig. 1). All trapping sites were adjacent to the wet markets and near residential and shop-lot houses. The sites were not more than 15 km from Kuala Lumpur. Chow Kit and Dato Keramat are situated right in the heart of Kuala Lumpur. At each location, 20 traps were set.

Trapping Sites for Rice Field Rodents

For rodents from rice fields traps were placed in fields at Kampung Sawah Sempadan, Tanjong Karang, (3°15′ N, 101°33′ E) Kuala Selangor which is about 80 km south of Kuala Lumpur (Figure 1). Trapping of rodents were conducted for eight weeks from June to July 2004. There were a total of 100 traps. Trappings were conducted during the post-harvest period when paddy fields were dry.

Trapping Sites of Coastal Rodents

For the coastal habitat, rodent trappings were carried out at the coastal areas of Port Dickson (Figure 1) for five consecutive nights. Hundred traps were set along the beach resorts, recreation centers, eating stalls, shops and in open fields near empty houses with tall grass around them.

Trapping of Rodents

Fruits, banana, coconut, sweet potatoes and dried fish were used as baits. The trapped animals were collected each morning and brought to the laboratory for further examination.

In all the four habitats, rodents were trapped alive using specially made wire traps measuring 29×22×50 cm (Figure 4). Trapped rodents were anesthetised, by placing them into a cloth bag containing cotton wool soaked with chloroform (Figure 5). Each animal was then tagged for identification.

Identification of Rodent Species

Besides physical and morphological features (see below), identification keys and illustrations developed by J. L. Harrison and Quah (1962), Medway (1983) and Junaidi Payne *et al*. (1985) were used to identify each rodent from the four habitats, down to the species level.

Morphological Measurements

Each rodent was removed from the cloth bag and measured using the criteria below:

i. Head and body length (HB), as measured from anus to the front of the nose.

Figure 2: Gombak Forest Reserve one of the habitats studied

Figure 3: Trapped forest rodents grouped together before collection for transfer to IMR, KL laboratory (traps were cleaned thereafter)

Figure 4: Rectangular rat trap used in the study

Figure 5: Rat transferred into cloth bag to anesthetize

ii. Tail (T), as measured to the tip of the tail excluding long fur or hairs which project beyond the end.
iii. Ear length (E), as measured from the external opening to the tip.
iv. Bodyweight (BW), the rodent weight was recorded using a standard weighing scale.
v. Hindfoot (HF), as measured from the heel to the tip of the longest toe, excluding the claws.

Physical Characteristics

The following external characters were noted for identification purposes.

i. Color of the dorsal surface (the back)
ii. Color of the ventral (belly) and whether the separation between the ventral and dorsal color is sharp or gradual.
iii. Whether there are spines interspersed within the dorsal fur.
iv. Color of the tail.

Sex and Age

The sex of the animal was determined by gross examination of the genitals. For juvenile rodents the distance between the anus and the urethral opening was measured. In males this distance is greater than in females. In addition the vagina of young females was completely covered with a translucent layer of skin. This appears as a small bald patch immediately at the distal end of the urethral opening. The development of the mammary glands was assessed. A rodent with well-developed glands was recorded as still feeding young ones.

RESULTS AND DISCUSSION

Rodent Species Recorded

A total of 204 rodents comprising 14 species were trapped from the four habitats. Of these 90 were males and 114 were females (Table 1). Morphological measurements of all rodents trapped in the four habitats are as presented in Table 2. These results are separately described and discussed below.

Urban Habitat

A total of 97 (47.5%) rodents comprising three species were trapped in the five urban locations. The house rat, *Rattus rattus diardii,* was the predominant species trapped (n=89) followed by *Rattus novergicus* (n=7) and one rat was *Rattus exulans* (Table 1). *Rattus rattus diardii* and *Rattus exulans* are commensals and are typically found in houses and live in scrub and cultivated areas. *Rattus rattus diardii* is one of the principal domestic rats in urban areas in Malaysia and Singapore (Zahedi *et al*., 1984). It is also found in fields and near human dwellings (Harrison and Quah, 1962; Lim, 1974). It is a pest and a reservoir host for various parasites, bacteria and viruses such as plague, scrub and murine typhus and other rat-associated diseases of public health importance (Sinniah, *et al*., 1979; Leong, *et al*., 1979).

Table 1: Distribution of rodent species trapped from four habitats

Rodent Species	Forest			Rice field			Coastal			Urban			Males/ Females	Total no of animals (%)
	♂	♀	Total	♂	♀	Total	♂	♀	Total	♂	♀	Total		
Maxomys rajah	6	6	12		-			-			-		6/6	12 (5.9)
Sundamys muelleri	4	6	10		-			-			-		4/6	10 (4.9)
Rattus bowersi	3	4	7		-			-			-		3/4	7 (3.4)
Leopoldamys sabanus	6	7	13		-			-			-		6/7	13 (6.4)
Maxomys whiteheadi	2	1	3		-			-			-		2/1	3 (1.5)
Rattus tiomanicus jalorensis	1	1	2		-		1	0	1		-		2/1	3 (1.5)
Rattus exulans		-			-			-		1	0	1	1/0	1 (0.5)
Rattus rattus diardii		-		20	12	32	8	8	16	33	56	89	61/76	137 (67.1)
Rattus norvegicus		-			-			-		0	7	7	0/7	7 (3.4)
Lariscus insignis	1	0	1		-			-			-		1/0	1 (0.5)
Sundasciurus tenuis	0	1	1		-			-			-		0/1	1 (0.5)
Callosciurus caniceps	0	2	2		-		0	1	1		-		0/3	3 (1.5)
Tupaia glis	2	0	2		-		1	2	3		-		3/2	5 (2.5)
Suncus murinus		-			-		0	1	1		-		0/1	1 (0.5)
Total = 14 species	**25/28 = 53**			**20/12 = 32**			**10/12 = 22**			**34/63 = 97**			**90/114 (44/56%)**	**204**

Table 2: Morphological measurements of rodents trapped in the four habitats studied

Hosts	Total animals	HB* mm	T* mm	HF* mm	E* mm	BW* grams	Mammae Pectoral (pairs)	Mammae Inguinal (pairs)
Maxomys rajah	12	140-235	140-217	35-46	20-25	80-265	2	2
Sundamys muelleri	10	165-245	195-300	42-52	21-25	150-470	2	2
Rattus bowersi	07	210-285	240-310	49-57	26-32	207-550	2	2
L. sabanus	13	180-255	270-415	42-50	23-28	200-410	2	2
M. whiteheadi	03	110-135	90-118	22-30	21-23	35 -75	2	2
Rattus t. jalorensis	03	125-180	125-198	28-32	16-22	55-152	2	3
Rattus exulans	01	150	156	33	20	50	2	2
Rattus r. diardii	137	131-270	130-257	30-40	18-25	100-290	2	3
Rattus norvegicus	07	200-244	150-210	32-42	20-22	250-475	3	3
Lariscus insignis	01	156	87	42	-	150	3	-
S. tenuis	01	120	95	31	-	65	3	-
C. caniceps	03	180-230	150-220	45-50	17	165-315	2	3
Tupia glis	05	135-205	125-195	42-49	15	85-185	2	3
Suncus murinus	01	103	75	20	10	58	-	-

Note: - = Measurements not carried out; * Values expressed as a range (abbreviations as in "Materials & Methods")

Rattus novergicus has in the past been reported to be found near houses close to ports. (Harrison and Quah, 1962). The presence of *Rattus novergicus* far inland in this study indicates that this particular species is slowly getting established in inland areas. These rats could have moved inland via the transportation of goods.

Forest Habitat

A total 53 (26%) rodents were trapped from the Gombak Forest Reserve habitat. There were ten different species of rodents comprising three families, Muridae (n =5), Suridae (n=4) and Shrew (n=1). Of the 53 rodents, 25 were males (47.2%) and 28 (52.8%) were females. *Leopoldamys sabanus* (n=13, 24.5%), *Maxomys rajah* (n=12, 22.6%) and *Sundamys muelleri* (n=10, 19%) were the predominant species trapped in this habitat (Table.1). According to Harrison (1955), the above three species including *Maxomys whiteheadi* are generally considered as ground dwelling species. *Rattus bowersi* and *Leopoldamys sabanus* were found to be bigger in size weighing between an average of 200-550 gms (Table 2). The morphometric measurements are similar to those reported by Harrison and Quah (1962) and Junaidi *et al.* (1985). Ho *et al.* (1985) reported trapping *Sundamys muelleri* and *Maxomys rajah* during their survey of small mammal parasites in Taman Negara. however they reported trapping only one sample of *Leopoldamys sabanus* whereas in the Gombak forest habitat this species of rodent was the most predominant. Chulan *et al.* (2005) reported *Maxomys whiteheadi* as the predominant rodent species in the Kuala Selangor Nature Park during a survey of small mammals. From data collected in this study, it appears that the Gombak Forest Reserve ecology is still an ideal environment for a wide range of wild rodent. Notably, not a single house mouse (*Rattus rattus diardii*) was trapped in the forest habitat. This could be because the location of traps was deep inside the primary jungle and away from human settlements.

Coastal Habitat

Twenty-two rodents (comprising 10 males (45.5%) and 12 females (54.5%) were trapped from the coastal habitat. *Rattus rattus diardii* (n=16, 72.7%) was the predominant species trapped followed by *Tupaia glis* (n=3, 13.6%), *Rattus tiomanicus jalorensis* (n=1, 4.5%), *Suncus murinus* (n=1, 4.5%) and *Callosciurus caniceps* (n=1, 4.5%). *Rattus tiomanicus jalorensis* is normally found living mainly in scrub vegetation, secondary forests and plantations. *Suncus murinus* is a house shrew usually found within buildings and houses and it is the smallest rodent species in this study, weighing about 58 grams and measuring about 103 mm from head to body.

Rice Field Habitat

A total of 32 (15.7%) rodents comprising 20 males (62.5%) and 12 (37.5%) females identified as *Rattus rattus diardii* were captured from this habitat. There were no other rodent species present. It was surprising to note that not a single species of the popular rice field rat, *Rattus argentiventer,* was trapped in this habitat. This particular rat has been reported to inhabit in large numbers rice fields in Southeast Asian countries like Indonesia, Malaysia and Vietnam and are a major cause of crop damage (Singleton and Petch, 1994). However, many common Malaysian rodents are reported to be versatile and capable of occupying a variety of habitats (Harrison, 1963). Their relative abundance in a specific habitat may vary therefore with time and may also be influenced by the other species of rodents present or by human activities. Thus, it is not possible to ascertain with certainty the reasons for the absence of *Rattus argentiventer* in the rice field habitat studied in this project.

CONCLUSION

Among the rodents trapped, the family Muridae was represented in all four habitats: urban, rice field, coastal and forest. A total of 137 (67.1%) rats were identified as *Rattus rattus diardi* and they were found living close to human activities. The Gombak forest habitat was found to be ideal for the survival of many different wild rodent species. A total of 10 different rodent species were trapped in this habitat. There were no major differences noted in the morphological measurements of rodents trapped from the four habitats with respect to that reported in the literature. However, the current study has limitations because the number of rodents sampled is small. But it does document the general rodent species observed in the four specific habitats. Further in depth studies should be undertaken to understand the relationship between a specific habitat and the abundance of rodent species present and their role in transmitting zoonotic pathogens to animals and humans. The Gombak forest reserve is a unique ecological environment which favors the breeding of many different species of wild rodents. However, it is fast losing its pristine ecological value due to the massive illegal human activities that are taking place. If the illegal human encroachment into the forest is not checked by the authorities it will have far reaching implications on the transmission pattern of certain rodent-borne zoonotic diseases (Paramasvaran *et al.*, 2009) and on the survival of some of the exotic species of wild rodents.

ACKNOWLEDGEMENT. The authors are grateful to the Director General of Health, Malaysia for permission to publish this paper. A special thanks to Jabatan Orang Asli, Jabatan Hutan Negara and the Orang Asli community in Gombak for their cooperation and assistance during the study period. We also like to thank the staff from the Pest Control Division of DBKL for their technical assistance in trapping rodents in the wet markets. This study was approved by the IMR Animal Ethics and Welfare Committee.

BIBLIOGRAPHY

1. Harrison, J.L. and Quah Siew Keen (1962). The house and field rats of Malaysia. *Bulletin No.12, Institute for Medical Research*. Federation of Malaya. pp. 38.
2. Ho, T. M., Nadchatram, M. and Saleh, I. (1985). Ectoparasites of rodents and bats from Taman Negara, *Tropical Biomedicine* **2:** 193-195.
3. Junaidi, P. Charles, M. and Karen P. (1985). A field guide to the mammals of Borneo. World Wildlife Fund Malaysia. Weng Fatt Sdn.Bhd., Kuala Lumpur, .
4. Lim, B. L. (1974a). Small mammals associated with rice fields. *MARDI Research Bulletin* **1**:25.
5. Lim, B. L. (1974b). Land use and small mammal ecology in Cameron Highlands, Malaya. *Federation Museum Journal* **XIX:** 45-56.
6. Lim B. L., Ramachandran, C., P. and Krishnasamy, M. (1974). Helminth infection among small mammals in Penang Island, Peninsula Malaysia. *Federation Museum Journal* **XIX**: 57-65.
7. Medway, (1983). The Wild Mammals of Malaya (Peninsula Malaysia) and Singapore. Second Edition, Oxford University Press 1969, Oxford London Glassgow.
8. Ow Yang, C. K., (1971). Studies on the nematode parasites of Malaysian rodents: The *Rhabdiasidae, Trichuridae* and *Oxyuridae*. *Journal of Helminthology* **XLV (2/3):** 93-109.
9. Paramasvaran, S., Sani, R.A., Hassan, L., Krishnasamy, M.1, Jeffery, J., Oothuman, P.4, Salleh, I.5, Lim, K.H., Sumarni, M.G.1 and Santhana, R.L.(2009). 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 *Tropical Biomedicine* **26(3)**: 303–311.
10. RatZooMan, (2006). Rats and human health in Africa: *Proceedings of an international workshop on rodent-borne diseases and the Rat ZooMan research project.* May 3-6, malelane, Republic of South Africa.
11. Roberts, T., J. (1977). Mammals of Pakistan. 1st edition. Ernest Benn, London, pp. 258-261.
12. Singleton, G. R., Lyn Hinds, Charley Krebs and Dave Spratt (2003). Rats, mice and people: an interwowen relationship. Rodent Biology and Management. ACIAR Monograph No.96.
13. Singleton, G. R. and Petch, D., A. (1994). A review of the biology of house mouse populations that plague irregularly: an evolutionary perspective. *Biological Journal of the Linnean Society* **41**:285-300.
14. Sinniah. B., Manmohan Singh and Khairul, A. (1979). Preliminary survey of *Capillaria hepatica* (Bancroft, 1893) in Malaysia. *Journal of Helminthology* **53**: 147-152.
15. Walsh, J. F., Molyneux, D. H. and Birley, M. H. (1993). Deforestation: effects on vector borne diseases. *Journal Parasitology* **106**: 55-75,
16. Zahedi, M., Jeffery, J., Krishnasamay, M., Bharat, V. J. (1984) Ectoparasites fauna of *Rattus rattus diardii* from an urban and semi urban environment. *Journal of the Malaysian Society of Health* **4 (2)**: 25-27.