

THE ROLES, THREATS AND DISTRIBUTION OF RODENTS IN MALAYSIA

(PERANAN, ANCAMAN DAN TABURAN RODEN DI MALAYSIA)

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ABSTRACT

Rodents are the world's largest group of small mammals with more than 2200 living species, comprising around 40 percent of all small mammal species existing today. Rodents are non-volant small mammals that weigh approximately less than 500g and inhabit various types of habitat such as grasslands, desert and even in human settlements. This review explained the roles, threats and distribution of rodents in the ecosystem they inhabit. Some species play critical roles as seed disperser, pollinator and even as laboratory subjects in many experiments. This article serves as an eye-opener about the rodent status distribution and abundance in natural and modified habitat, especially in Malaysia. This review of literature can provide knowledge to people to know more about rodents.

Keywords: Rodent; Distribution; Malaysia, Habitat, Roles

1. Introduction

Malaysia is known as one of the biodiversity destinations in the tropical region of Southeast Asia (Ramli & Hashim, 2009). The presence of various types of habitats contributes to high richness of faunal diversification including various species of rodents.

Rodents are the world's largest group of small mammals with more than 2200 living species, comprising around 40 percent of all of the small mammal species existing today such as *Maxomys rajah* (spiny rat), *Rattus tiomanicus* (Malayan wood rat), and *Tupaia glis* (tree shrew) (Voss & Emmons, 1996). These different species of rodents are found throughout the world except for certain countries such as Antarctica, New Zealand, and few oceanic islands (Assefa & Chelmala, 2019). Known to have high adaptation level, rodent's distribution pattern is scattered widely everywhere. Even so, in the community, some rodent species possess habitat preference which means they need a certain specific habitat or ecosystem to survive. Some rodents, such as kangaroo rats stay in the desert and eat mainly seeds. These herbivorous rodents have high fiber requirement and easily exposed to infection if their dietary requirement is insufficient. Some species, such as endemic giant mole rat *Achyoryctes macrocephalus* and the brush-furred mouse *Lophuromys melanonyx* inhabit natural habitat because they are adapted to the Afroalpine environment due to their physical ability and attribute that allow them to avoid temperature fluctuations by hiding in the burrows (Bennett, Jarvis & Davies 1988). Generally, the habitat preference of rodents depends on the environmental factors, like climatic conditions, food sources, predation and habitat exploitation by humans.

2. Roles of Rodent

2.1. Rodents Burrowing Activities

Rodents appear to have a few significant roles for their burrowing activities. They transported elements across the soil profile, especially in dry habitats such as grasslands with no upward movement of the deep ground water and in the change of physio-chemical conditions of the upper soil layer (Bennett et al., 1988). This action indirectly influences the decay of organic matter and water storage in the soil. Gillison and Anderson (1981) examined on the structure and function of above and below ground community by measuring the response of plant community, soil fungal abundance, microbial activity and potential net nitrogen (N) mineralization. They found out that rodents' enclosure had no effect on bacterial and fungi abundance nor did the exclusion affect potential nitrogen mineralization. However, they did find out that the extracellular enzyme activity was higher (the increase of C3 graminoids).

2.2. Rodent as Laboratory Subject

Rodents especially the domesticated strain of the house mouse provides human with truly necessary laboratory subjects in physiology, psychology and diseases including cancer. About 95% of lab animals derived from mice and rat's species are used to formulate new drugs, such as for curing cancer or testing dietary supplements (Baumans, 2005). Among many reasons of using this species is that they have small body size and high adaptations towards new surroundings. Mice and rats are also relatively inexpensive compared to other species and therefore they are affordable and available to be purchased in large quantities. Commercialised companies for research purposes usually breed these species. These species also gentle making them more docile compared to other small mammals' species (Cook, 2001) and inbred so that aside from sex differences, they are identical genetically almost to human to produce more uniform medical trials' results (Baumans, 2005). This makes rodents as the closest animals that resemble human genetic and biological characteristics along with human behavior.

2.3. Rodents Behavior on Vegetation and Soils

Generally, rodents bring influences on both physical and chemical properties. To be specific, in vegetation, rodents could affect primary productivity, plant species structure, and the decomposition rate of plant resources. This primary productivity is known as a rate of energy converted into organic substances by photosynthesis organisms. Although rodents are typically inconspicuous, their impact on plant community structure and chemical could be significant as they may consume as much as 60% (Feldhamer, 1979) to 80% (Gillison & Anderson, 1981) of the total annual primary plant production. Light grazing by rodent species in habitats such as forest and grassland can stimulate plants' production. For example, moderate grazing from voles (*Microtus oeconomus* and *M. middendorffii*) stimulated new shoot growth of plants, which further increases the population of the plants. Besides that, resulting from the grazing of hispid cotton rats (*Sigmodon hispidus*) on the rye grass, the grass grows back faster than the one that was cut by using machines (Feldhamer, 1979).

The rodents' saliva contains biochemical agent that reacts with the components of the grass or the removal of any specific tissue of the grass during grazing that stimulates the grass growth. Plants and herbivores can create mutualism interactions. Animal saliva contains growth factors that are probably the key factors which are to related plant compensatory responses to

herbivory. The growth of perennial grasses can be enhanced by usage of animal saliva to accelerate the mobilization of photosynthate reserves which can increase the plant's biomass (Liu et al. 2012). Saliva can give beneficial effect for plants especially to tolerate herbivory and be fitted to grazing system (Liu et al. 2012).

The grazing activity proves the contribution of rodents on the decomposition rates of plant materials by altering the chemical quality of the litter by inducing chemical defenses and increasing the concentration of secondary metabolites in foliar material, which can also retard microbial activities and decomposition rates of the plant litter (Brown, 2002). Ruppert, Mansor and Anuar (2015) concurred by stating herbivore rodents that respond with wide food consumption range leads to an increment in soil microbial activity and potentially increase the nitrogen mineralization rates, leading to positive feedback to the plant community and increased decomposition rates.

2.4. Rodent as Pollinators and Seed Dispersers

Rodents were acknowledged as pollinators and seed dispersers of the tropical rainforest ecosystem from 80 years ago (Campos, Campos, Giannoni, Rodríguez, Albanese & Cona, 2017). For example, a special pollination relationship occurred between an endangered shrub, *Leucospermum arenarium* and rodent where *L. arenarium* is geoflorous inflorescences. This make rodent as the perfect pollinators to consume as it is more accessible and thus, much easier to spread the seeds. Early study conducted by Johnson and Pauw (2014) identified that rodents' pollination results in plants produced with unique vegetative traits. They also found out that rodent faces contain more pollen than the fur does as the percentage of pollen accidentally ingested while the rodents were grooming themselves is higher compare to the pollens that were directly consumed, intentionally.

3. Threats of Rodent

3.1. Rodents as a Mycotoxins Transmitter in Agricultural Sector

Mycotoxins are toxigenic fungi even though it is derived from the nature. Mycotoxins are produced by different species of fungi (moulds) that later grows on surfaces and this brings concerns to the agricultural sector farmers. Moulds often grow on surfaces and crevice where crops spillage happened from rodents' aggressive behaviors in order to feed on the seeds, barley or grains. All farmers of grain stores classified rodent as a very dangerous seed-feeders because they are efficient fungi vector. It was documented in one of Czech grain stores where mycological analysis was performed on house mouse faeces resulted in 35 fungi species in the faeces (Frankova, Stejskal, Rodl & Aulicky, 2016). The observed fungi were *Aspergillus niger* and *Penicillium aurantiogriseum*, which have the potential to produce the dangerous chemical of mycotoxins. Rodents as a Pathogen Vector

Rodents are threat towards public health. The rodent-borne diseases are possible to spread via two different pathways. Direct contact is the first pathway when human or animals are bitten by rodents, come in contact with contaminated water containing rodents' urine (leptospirosis) or breathing in contaminated air particles by rodents' excrements (Hantavirus) (Meerburg, Singleton and Kijlstra, 2009). The second pathway is by indirect route. Rodents also can act as intermediate hosts of ticks or mites that carry the pathogens directly to humans. Then, without breaking the chain, these host (rodents) then are consumed by farm animals (cow, sheep) that

later will transfer the pathogens to human and will cause diseases if the farm products are not thoroughly cooked (Meerburg et al., 2009).

These rodent-borne diseases are deadly, and some can even cause death by viruses, bacteria and parasites. As for viruses, the most common disease is Hantavirus Pulmonary Syndrome (HPS), where it was first recognized as an acute disease attributable to Hantavirus genus, Bunyaviridae family from South Western part of the United States (Meerburg et al., 2009). HPS often distinguished by its symptoms of bilateral interstitial pulmonary infiltrates and acute respiratory distress syndrome (ARDS). Infected individuals will undergo prodromal phase for three to five days and consecutively, will through another phase where there is hypotension for the next two to five days.

Another common disease which is caused by parasites are, toxoplasmosis by *Toxoplasma gondii*. Cat act as definitive host the moment they are infected when they prey on the intermediate hosts such as mice and rats. Then, livestock animals (intermediate host) will be infected when oocytes are shed along with the cats' faeces and if they accidentally or indirectly ingested it, it will result in tissue-cysts in the animals' meat and organs (Meerburg et al., 2009). The moment human is infected is when they consume the livestock products such as meat without the right method of cooking. For any ingredients though, it is required to be thoroughly cooked or else all the bacteria or parasite will still be alive and are able to survive to be transferred to humans. As a result, human will be infected with non-symptoms acute infections.

3.2. Rodent Bad Impacts on the Environment

Rodents cause threats to the environment badly with their urine, faeces and furs. As found by Frankova et al., (2016) in his evaluation, it was recorded that an average of sixty-six pieces of faeces are excreted daily by a single caged rat while, Chame (2003) estimated that seventy pieces of faeces are excreted daily by a caged mouse. Therefore, theoretically, a mouse itself can excrete a minimum of 30 000 droppings in a place for entire one year and might cause big problems, as these species are known to be living together in human environment in every spaces and crooks of buildings. For example, roof rats can usually be found in the upper part of any construction or buildings as they are known to have great climbing skills. Thus, their habitats remain undisturbed by humans. With such large number of droppings in any building, it is inevitable for these spaces to be contaminated if the droppings fall down causing bad smell in the spaces of these buildings. Besides, the accumulated droppings can possibly cause other secondary infections.

4. Rodents in Malaysia

Generally, Malaysia have about 440 species of mammals' diversity been recorded and reported of which 66 species (15%) are endemic to Malaysia (Payne, Francis & Philips, 1998; Francis & Barret 2008). Rodents are the most widespread species that have important roles in any type of ecosystems in the world, especially in tropical rainforest. Rodents have a very high adaptation level allowing them to be able to survive in most environments. such as deserts, forests and even manmade structures, such as building and housing areas. In rodents' population, habitat selection and habitat preference aspects are crucial as their life's necessities where some species only live-in specific habitats and areas while other species live scattered in several different areas. Most species prefer to live in natural habitats such as forest, mountain

and grasslands but out of all the species members, rats and mice are among the most adaptive species regarding their habitat and diet.

4.1. Natural Habitat

Some endemic species such as giant mole rat, *Tachyoryctes macrocephalus* and brush-furred mouse, *Lophuromys melanonyx* are restricted to live in natural habitat because they are already adapted to the afroalpine environment due to their ability to avoid temperature fluctuations by hiding in the burrows (Bennett, Jarvis & Davies, 1988). Jayaraj, Tahir, Udin, Baharin, Ismail & Zakaria (2012) managed to catch two endemic species in a large forest in Kelantan, Malaysia, in Gunung Stong State Park. Six *Leopoldamys sabanus* and two *Maxomys whiteheadi* were caught deep in the forest proving that these species only exist in tall old secondary forests and far from human disturbances. Wilson, Helgen, Yun and Gimán (2006) also caught *Maxomys whiteheadi* in a fragmented forest in Borneo while Chuluun, Mariana, Ho and Mohd Kulaimi (2005) recorded species existence in a mangrove swamp and secondary forest of Kuala Selangor State Park, Selangor, Malaysia. Both species of *Leopoldamys sabanus* and *Maxomys whiteheadi* are common in many types of forest in Malaysia because these endemic species of rodents have a particular diet which is accessible in the forest such as fruits of shrub, mushrooms, and other small invertebrates. By living in the forest, these species will not need to forage to another habitat especially to human settlements. Furthermore, rodent's species have high values in our ecosystem including ecological, scientific, social and economic. Rodents can act as seed and spore dispersal, help in pollination, circulate energy and nutrient and as a food source for many predators when they remain in their natural habitat (Dickman 1999). But there is a need for more comprehensive studies to identify the preferences of habitat for these species in future studies. It is important to find out the factors that help for distribution of local fauna especially rodent and plans for conservation action.

4.2. Modified habitat

Modified habitat is actually a disturbed natural habitat, which makes it desirable for certain species of rodents (Loveridge, Wearn, Vieira, Bernard, & Ewers, 2016). Apart from high food resources in the modified habitats, some species prefer modified habitats to natural habitats because of low numbers of large trees, allowing growth of vegetation layers, preventing their predators away. According to Paramasvaran et al. (2013), not a single individual of house rat such as from *Rattus spp.* was caught in the natural habitat (forest) during their survey. The reason is that the traps were deep inside the forest and were far away from human settlements. These species are known as commensals, which can be typically found in houses, scrub, and cultivated areas. In Amni et al. (2019) study, *R. rattus* were mostly caught in residential areas and commercial areas of Penang Island, Malaysia for their high resource availability especially as foods resources. The present study is not the actual result diversity found in the area being examined. However, this study managed to find that modified habitats contribute to the distribution of important commensals and other species, which have the ability to adapt and to live in human habitations and nearby agricultural fields. Therefore, ecologically based rodent management is crucial for conservation. Diversity and Abundance of Rodent in Natural Habitat, Urban and Rural Area

Rodents are known to be the most numerous and diverse species of existing mammals. However, it can vary in different environments such as urban area, rural areas and natural

habitats. According to William-dee et al. (2019) who conducted a study in Tasik Bera, Malaysia (natural habitat) and the place was recorded to be more diverse than Penang Island (urban area)

Tasik Bera has higher species variants with 21 species that were caught while Penang Island has lower diversity because of cosmopolitan species. The surveyed site at Penang Island is a disturbed area as it is exposed to human disturbance from recreational park and the main road.

Being one of Malaysia's largest natural lake and is separated from any human activities, Tasik Bera provides foods and clean water source for rodents such as *Leopoldamys sabanus*, *Maxomys rajah*, and *Rattus exulans*.

Kumaran, Khan, Azhar, WeeChen, Mohd Ali, Ahmad, and Yusoff (2016) recorded that rodents' species at Gunung Reng, Kelantan, Malaysia (rural area) was found to be low in diversity. As the study site was located in banana plantation, *Rattus rattus* as found as the most captured species (25 individuals) while species like *M. rajah* and *M. whiteheadi* were barely captured. This is because, *Rattus rattus* species is considered as pests and these rodents killed by villagers to protect their crops and plants. Rodenticides was used to kill the pest species but this non-selective method had accidentally killed other rodent species that feeds on the Rodenticides poison resulting in low abundance and diversity of other species in rural areas. The same abundance of *Rattus tiomanicus* was recorded by Santosa and Rejeki (2019) at an oil palm plantation in Indonesia. This species becomes pests because of the existence of abundance of food source such as oil palm fruits, insects and molluscs. All these studies show that rodents' species is low in terms of their diversity and abundance at both urban and rural areas. In contrast, the diversity and abundance are high in their natural habitats. Characteristics of the habitat structure obviously differ among forest types where natural habitats have larger and denser tress, and meanwhile urban and rural area have high canopy openness areas with no trees. First, to protect small mammals' diversity and second, to practice proper land-use management, further information about the effect of various forest uses on small mammals and a comprehensive understanding of landscape-level effect are urgently needed.

4.3. Distribution of Rodents in Malaysia

Rodents belonging to the Muridae family are extremely successful and they are from a dominant species in most region of the world, largely due to their ability to adapt and exploit new situation rapidly (Singleton, 2003). A general decrease of number in the rodent species diversity was identified to have occurred in Peninsular Malaysia resulting from human activities of deforestation and land development. Ruppert, Mansor & Anuar (2015) recorded that the distribution of both wild and urban rodent species from four different habitats, such as urban, agricultural, forest, and coastal in Negeri Sembilan and Selangor. The study aims to identify the habitats preferred by rodents when their natural habitat were disturbed due to increase of agriculture, deforestation, and urbanization. In 2018, a study conducted by Gentile, Cardoso, Costa-Neto, Teixeira & D'Andrea, (2018) emphasized on the importance of wildlife inventories in providing useful information to uncover underrepresented diversity and to improve management plans. Their study involved inventories in aiding authorities to improve their present conservation and management plans for the volant and non-volant small mammals in various areas with contrasting habitats in Peninsular Malaysia. Besides, in Kelantan, Kumaran et al. (2016) documented the diversity, distribution and conservation status of small mammals (rodents) of the state. In conclusion, studies about rodents in Malaysia mainly focused on

diversity and distribution patterns as an early step to identify and record all the existed species in order to conserve and creates public awareness on the species.

5. Conclusion

To conclude, it is important to conduct studies on rodent species in the future as rodents plays critical role in the ecosystem, especially in the natural habitats and modified habitats. These studies can determine the status of our rodent species, create awareness and provide more knowledge and information to people about rodents apart from just being categorized merely pests.

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