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Topographical differences impacting wildlife dynamics at natural saltlicks in the Royal Belum rainforest

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ABSTRACT

Natural saltlicks play an important role in the diet of a wild herbivore to supplement their nutritional deficiencies. Saltlicks also serve as rally points for wildlife species, as they determine the distribution and density of prey species which in turn affects predator population. The objective of this study is to determine the relationship between saltlicks of different topography (e.g., *Kuak*, *Batu* and *Tanah*) and the wildlife diversity at the Royal Belum rainforest, Malaysia. Results showed that *Kuak* is near the main river and surrounded by dense shrubbery which provides ample camouflage for solitary herbivores such as muntjacs. *Batu* is surrounded by rocky architecture and sub-canopy trees, hosting larger mammals such as elephants and tapirs whereas *Tanah* is surrounded by a wide plain area with a small stream making it a suitable environment for herd animals such as sambar deer. This could indicate that topography is a crucial factor for wildlife in frequenting saltlicks for important physiological and sociological interactions. Indeed, information on saltlick topography and animal diversity is beneficial for the study of wildlife population and conservation of the ecosystem.

Key words: Topography, saltlick, wildlife, ecosystem, Royal Belum rainforest

INTRODUCTION

Saltlicks are naturally occurring deposits that are rich in minerals mainly sodium, potassium, fluorine, chlorine, calcium, magnesium, sodium and zinc (Tracy and McNaughton, 1995). These minerals play a significant role in aiding many species with digestibility as well as in detoxification of plant secondary compounds via clay adsorption (Ayotte *et al.,* 2006). Previous study on saltlicks in Deramakot, Sabah reported that 78.4% of the species identified to be living in the forest reserve was recorded at the saltlicks (Matsubayashi *et al.,* 2006). These species included herbivores, frugivores and carnivores. It is expected that saltlicks with higher concentrations of sodium were preferred by animals like sambar deer and bearded pigs due to their mineral demands (Matsubayashi *et al.,* 2006). The mineral concentrations also affected the ranging patterns and distribution of the sambar deer and bearded pigs. In fact, the importance of saltlicks is linked to the lower foliar concentration of minerals in tropical plants due to depletion of major cations in the soil (Siteinei *et al.,* 2011). Thus, minerals in saltlicks are a major importance in the diet and wellbeing of herbivores and frugivores and may play a role in the distribution of predators.

Different ecological mechanisms and biological interactions acting simultaneously will determine species distribution and dynamics around saltlicks (Fortunel *et al.,* 2018). For instance, factors such as location, topography, surrounding forest structures may affect variation in the composition of visitors to saltlicks of different geometric characteristics (Molina *et al.,* 2013). It can be inferred that habitat characteristics of different saltlicks predetermine the potential presence or absence of different species. According to Molina *et al.* (2013) stated that a saltlick located on the top of a ravine was utilized by primates and bird species whereas the same saltlick on the bed of the creek played host to terrestrial species such as the Spotted paca (*Cuniculus paca*) and the Black-eared opossum (*Didelphis marsupialis*). This could indicate that the effects of topography, among other factors are evident to influence wildlife dynamics at saltlicks, hence identifying these factors should be a priority for subsequent research.

In a tropical country, the topography influences the number of natural saltlick and the ecosystem of the rainforest. The Royal Belum rainforest, Malaysia is one of the tropical lowlands and hill dipterocarp virgin rainforests, spanning over an area of 290 hectares (Rayan *et al.,* 2012). In 2012, the Royal Belum rainforest was gazette as a forest reserve and as a National Heritage Site by the Government of Malaysia. This rainforest is rich in flora and fauna which are characteristics of a typical rainforest in Peninsular Malaysia (Misni *et al.,* 2017). Therefore, the researchers will identify the saltlicks in the Royal Belum rainforest of topography and their influence on wildlife diversity. We hypothesize that the topography of different saltlicks will play a role in determining the species of animals utilizing the saltlicks. Thus, information from this study will enable

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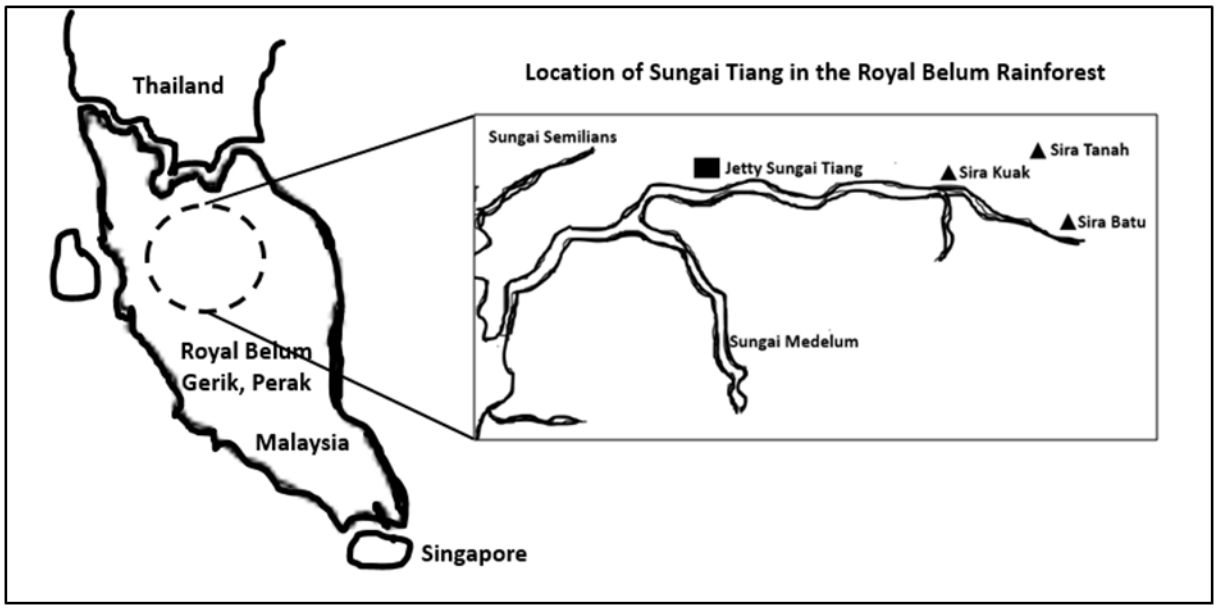

Figure 1. a) The location of Royal Belum rainforest in Malaysia and Sungai Tiang.

researches on wildlife to be planned around saltlicks with specific criteria's that might influence wildlife distribution which will aid in conservation of Malaysian wildlife.

MATERIALS AND METHODS

Location of study

The study area chosen was to Royal Belum rainforest, which is in Gerik, Perak Malaysia. This 130-million-year -old forest located at coordinates: [N50 34 58.34 - 50 56 4.13 and E101 15 30.7 - 101 41 51.46] has a total coverage of 290 000 hectares, located close to Thailand's Bang Lang National Park and Hala-Bala Wildlife Sanctuary (Kedri *et al.,* 2018). The forest is divided into two area, the Upper Belum area, which stretches to the Malaysia-Thailand border and the Lower Belum area covered by the Temengor Lake. The sampling area at Sungai Tiang is located 8 km from the jetty at the Lower Belum, Complex. Three saltlicks such as *Kuak*, *Batu* and *Tanah* were identified at Sungai Tiang based on animal trails, footprints and camera trap. We focused on these saltlicks due to high incidences of animal footprints of difference species around them. Figure 1 A and B shows the location of the Royal Belum rainforest in Malaysia and three saltlicks at Sungai Tiang, respectively. The permit of data sampling in Royal Belum rainforest was approved by the Perak State Park, Malaysia and Department of Wildlife National Parks (PERHILITAN) Peninsular Malaysia.

Data recording by the camera trap

We used the camera trap (Model: LTL-5210A – 12MP) to identify the frequent of wildlife in the three saltlicks. We placed the camera traps at locations visualizing the saltlicks with the presence of animal trails to increase the probability of getting images. We set up the cameras about 1.5 meters off the ground and immobilized them using bungee cords wrapped around the tree. Individual cameras required 8 AA batteries (Brand: Energizer) and will last approximately 1 month depending on frequency of capture or based on movement trigger. Each camera is equipped with infrared sensors that enable the camera to recognize and be triggered by the movement of animals to take 20 second short video. We equipped each camera with a 16-gigabyte memory card (Brand: SanDisk 16BG) that records the images or video captured. We changed new set of batteries and memory card for the cameras for 6 times within 6 months duration of study. All data on the memory cards were played back with windows media player and the images were recorded and tabulated using an ethogram procedure according to the species of fauna and number of sightings at each saltlick. We recorded the number of sightings of different animals captured using the cameras according to species. Animals of the same species captured again during a 15-minute period was counted as one individual.

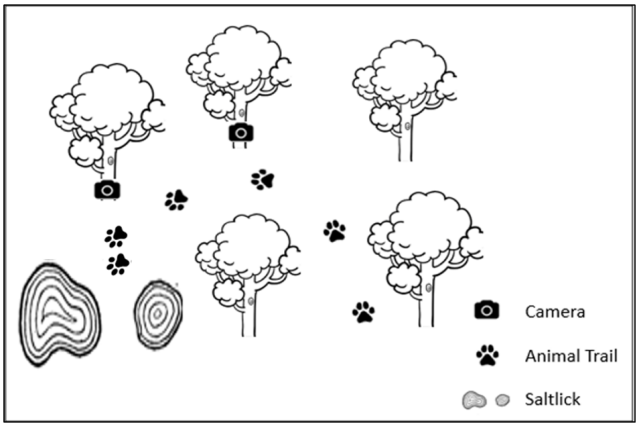

Figure 1. b) The position of camera trap settings concerning animal trails and natural saltlick located at the Royal Belum rainforest, Malaysia.

Saltlick parameters

The first parameter was the size of the saltlick using, which we measured using a tape which we brought. The

Table 1. The different topography of the three saltlicks at Royal Belum rainforest, Malaysia

Parameters scrutinised	Natural licks observed in Royal Belum rainforest		
	Sira Kuak	***Sira Batu***	***Sira Tanah***
Size (area)	$92m^2$	$52m^2$	$20m^2$
Location	Close to the river of access (50m)	About 3 km away from river of access	About 3.5 km away from river of access
Vegetation	Thick shrubbery and bushes, all around. Some large trees ~2m away, no open area.	Minimal shrubbery. Presence of subcanopy trees and nearby bamboo forest.	Large, relative flat, open area. Presence of small shrubs surrounding.
Animal access	Difficult for all species	Easy for all species	Easy for all species
Surrounding characteristics	Thick, dense vegetation surrounding the saltlick.	River access (stones). Embankment on 3 sides.	Embankment on one side, large plains all around.

larger saltlicks were measured using the GPS tracker system. The second parameter was the location to the river of access, which was the distance from the river, measured using the GPS tracker device. Other characteristics of the saltlicks considered was the surrounding vegetation in terms of trees and bushes and the surrounding characteristics which were described using observational qualities such as stones, nearby streams, and slopes. We also hypothesized the ease of access of animals based on the footprints found in each saltlick together with the density of surrounding vegetation.

Data analysis

Data obtained from the studies were analyzed with MedCalc Statistical Software version 19.0.4 using one-way analysis of variance (ANOVA) with repeated measures followed by post hoc least significant different test. All data are reported as mean ± SD and statistical significance was described as a *P*-value of less than 0.05.

RESULTS

Table 1 shows the different topography of the three saltlicks, *Sira Kuak*, *Sira Batu*, and *Sira Tanah* at Royal Belum rainforest, Gerik Perak. The parameters discussed include size of the saltlick, location in relation to the river, surrounding vegetation, ease of animal access and surrounding characteristics. These parameters were used to associate different species of wildlife frequenting saltlicks for mineral supplementation by taking the density of cospecies sighted at the saltlick and associating the parameters with the natural behavior and preferred habitat of the documented species.

A one-way ANOVA test was conducted to compare the presence of muntjacs deer (*Muntiacus muntjak*) at the three saltlicks of different topographical characteristics (Table 2). There was a significant difference ($P<0.05$) of Muntjacs presence at the three saltlicks. A post-hoc comparison using the Tukey-Kramer test indicated that muntjacs at *Sira Kuak* was significantly different (56.0 ± 2.45; $P<0.05$) compared to *Sira Batu* (25.0 ± 2.00) and *Sira Tanah* (21.0 ± 0.82).

At *Sira Batu,* a one-way ANOVA and post-hoc comparison revealed that elephants (*Elephas maximus*) had significantly higher sightings ($P<0.05$; Table 2) at *Sira Batu* (16.0 ± 2.10) compared to *Sira Tanah* (2.0 ± 0.82) and *Sira Kuak* (5.0 ± 0.82) In addition, using the same statistical analysis, the number of tapirs (*Tapirus indicus*) were significantly higher at *Sira Batu* (7.0 ± 1.00: $P<0.05$) compared to *Sira Tanah* (2.0 ± 0.82) and *Sira Kuak* (3.0 ± 0.82).

A one-way ANOVA followed by the post hoc Tukey-Kramer test revealed that at *Sira Tanah,* sambar deer (*Rusa unicolor*) had significantly higher sightings (43.0 ± 1.63; $P<0.05$; Table 2). However, at *Sira Kuak* and *Sira Batu*, sambar deer had sightings at 25.0 ± 0.81 and 27.0 ± 1.00, respectively. Other animals include birds, porcupines, lesser mouse deer, Malayan sun bear, small-clawed otters, pig-tailed macaques and wild boars were recorded at these three saltlicks with small numbers of sightings.

DISCUSSION

Sira Kuak spans an area of $92m^2$ and is located closest to the river of access, which is also the point of human contact. The saltlick is surrounded from all sides by thick dense vegetation, made up of shrubbery and vines. The highest numbers of animals to utilize *Sira Kuak* are muntjacs (*Muntiacus muntjak*). The topography of the area with its thick shrubbery and bushes can prove invaluable for solitary small ungulates such as muntjacs to hide. In fact, the area is suitable to the behavioral characters of the muntjacs which are solitary, forest dwelling ruminants that choose to inhabit and hide in thick covers to avoid predation (Teng *et al.,* 2004). There were no large ungulates or carnivores documented at *Sira Kuak.* Studies on larger ungulates reported that herbivores such as sambar deer (*Rusa unicolor*), preferred open areas where they can look out for predators (Simcharoen *et al.,* 2014). Wildlife tolerance towards human interaction suggests that carnivorous animals are less tolerant due to their sensitivity to movement and their general degree of responsiveness (Samia *et al.,* 2015).

Table 2. The number of sightings of different species at the saltlicks located in the Royal Belum rainforest

Wildlife (species)	*Sira Kuak*	*Sira Batu*	*Sira Tanah*
Muntjac (*Muntiacus muntjak*)	56.0±2.45*	25.0±2.00	21.0±0.82
Tapir (*Tapirus indicus*)	3.0±0.82	7.0±1.00*	2.0±0.82
Asian Elephant (*Elephas maximus*)	5.0±0.82	16.0±2.10*	2.0±0.82
Sambar Deer (*Rusa unicolor*)	25.0±0.81	27.0±1.00	43.0±1.63*
Malayan porcupine (*Hystrix brachyura*)	0.0±0.00	1.0±0.00	2.25±1.50
Brush-Tailed Porcupine (*Atherurus macrourus*)	0.0±0.00	0.0±0.00	1.0±0.00
Lesser Mouse Deer (*Tragulus kanchill*)	5.5±0.57	0.0±0.00	1.0±0.00
Panther (*Panthera pardus*)	1.0±0.00	0.0±0.00	0.0±0.00
Pig-Tailed Macaque (*Macaca nemestrina*)	5.0±0.81	0.0±0.00	1.0±0.00
Malayan Sun Bear (*Helarctos malayanus malayanus*)	0.0±0.00	0.0±0.00	1.0±0.00
Indigenous People	6.0±0.00	1.0±0.00	0.0±0.00
Bats	12.75±1.50	5.0±2.00	0.0±0.00
Birds	16.0±1.50	0.0±0.00	9.0±0.81

Sira Batu is the second saltlick scrutinized for this study and covers area of over about 52m^2. A small portion of it is facing a small river with a stony architecture whereas the other portions are slight embankments on all sides with multiple animal trails, which provides no issues for larger animals to navigate. This area is surrounded by large trees with minimal shrubbery. The saltlick was nearby a bamboo forest, which had evidence of Asian elephants (*Elaphas maximus*) presence, seen by the broken bamboo and the elephant tracks and feces which explains high elephant presence at *Sira Batu*. Bamboo is an important substitute for grasses for elephants in the tropical forests (Spinage, 1994). In addition, tapirs (*Tapirus indicus*) recorded the second highest appearance at *Sira Batu*. Movements of tapirs are dependent on resource availability such as saltlicks and food source, where these herbivores develop geophagy and display mating behavior (Gonzalez *et al.,* 2017). The water source and presence of many sub-canopy trees adjacent to the saltlick makes *Sira Batu* a suitable habitat, as sub-canopy and under-story trees are a major part of a tapir's diet (Simpson, 2013).

Sira Tanah is the smallest saltlick among the three spanning an area of about 20m^2. There is a steep embankment on one side of the saltlick and a vast flatland with minimal plants extending about 30 meters around the saltlick. There is a small stream located in front of the saltlick and the saltlick drains from one end into the stream. The saltlick is easily accessible for all species and there is ample space for herd animals. This saltlick recorded high numbers of sambar deer (*Rusa unicolor*) probably due to the large area where herd animals can aggregate. Distribution and abundance of sambar deer were positively associated with relatively flat areas of river valleys, attributed to the vegetation quality, water source and predator detection (Simcharoen *et al.,* 2014).

Herbivorous animals such as sambar deer, tapirs, muntjacs and Asian elephant are frequent saltlicks because of their dietary need for sodium supplementation due to the low sodium from tropical plants. There is a widespread occurrence of nutrient depletion and infertile soils in the tropics thus limiting plants productivity and concentrations of minerals (Vitousek *et al.,* 2003). An entire food-web may exist around the saltlicks due to the dependency of herbivores on saltlicks for mineral supplementation. This study detected different herbivorous mammals; however, there is a lack of the carnivorous species. The lack of carnivores might be attributed to the camera placements, which were mostly facing the saltlick, the number of cameras as well as the limited chances of obtaining a rare species at the right moment. However, previous studies revealed that images of predators have been captured at the saltlicks (Matsubayashi *et al.,* 2006; King *et al.,* 2016). This may be due to the placement of multiple cameras along animal trails around the saltlicks and trails leading to the saltlicks.

In conclusion, saltlicks are proven to be a huge part of the ecology of herbivorous mammals in the Royal Belum rainforest. Considering that carnivores obtain minerals from their prey, saltlicks are invaluable potential hunting grounds. Thus, natural saltlicks are not only an essential-resource for plant-eating mammals, but also perhaps a vital hunting ground for predatory mammals (Matsubayashi *et al.,* 2006). Distribution of saltlicks in forests will affect the ranging pattern of herbivorous species, thus natural licks determine the distribution and density of predators. Therefore, natural saltlicks should be considered a high priority in wildlife diversity and conservation in the forest.

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