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RESEARCH PAPER

Journal of Biodiversity and Environmental Sciences (JBES)

ISSN: 2220-6663 (Print) 2222-3045 (Online)

Vol. 8, No. 2, p. 255-264, 2016

<http://www.innspub.net>**OPEN ACCESS**

Comparative diversity and composition of small non-volant mammals in areas found on Soccsksargen Region, Philippines

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Article published on February 28, 2016

Key words: Rodents, Morphological Attributes, Data Analysis, Biodiversity, Mindanao.

Abstract

Eight species belonging to *Muridae* and *Viverridae* family were documented and collected in the three sampling sites: Polomolok, South Cotabato; Upper Biangan, Malungon, Sarangani Province and; K'laja, Conel, General Santos City. Philippines contain unique small non-volant fauna, which can be seen in greater Mindanao, the second largest island of the country, that has not yet been studied that much and still lacks information predominantly on areas like South Cotabato, Sarangani and General Santos City. This study was conducted to determine the different species found in three sampling sites on agricultural landscapes in selected areas of SOCCSKSARGEN. Sampling was done on October – December of 2015 using baited Sherman trap cages that were set through the three sampling sites. Species *Rattus everetti* was the dominant and most abundant group along the three sites. Species diversity is low as well as endemism; furthermore, there is observed much significant difference in species evenness and species richness. However, the study provides vital information about the current diversity of small non-volant mammals residing on certain parts of SOCCSKSARGEN region.

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Introduction

Philippines is known for its rich concentration of diversity and high level of endemism of mammals which is associated to the geological setting of the archipelago (Balete *et al.* 2009). Philippines also support one of the world's most distinctive fauna (Heaney *et al.*, 1998) due to remarkable series of small mammals found on its mountains (Thomas, 1898).

In the latest account, there are at least 103 species of small non-volant mammals and 93 (90%) are found to be endemic in the Philippines (Heaney *et al.* 2010) and about 80% of these are found on greater Mindanao, the second largest island in the country, that are nowhere else found in the world (Jalique *et al.*, 2015).

Small non-volant mammals are identified as species group to monitor in recognition of the abundant and varied ecological functions in ecosystems; (Marcot and Aubrey 2003) as consumers, small mammals may influence the nutrient dynamics of ecosystems or distributions of plant populations. These ecological relationships of small non-volant mammals have been shaped by their dependence on natural habitats (Ricart *et al.*, 2007). They also have varied patterns and range of distribution; they may be affected by the habitat type and other factors such as temperature, precipitation, competition and predation (Heaney, 2001). But still, small non-volant mammals are not given attention because they usually occur in complex communities with high species richness (Wells *et al.*, 2004).

With the discovery that several sub centers of endemism exist within islands, information on the diversity and distribution of small non-volant mammals is continually increasing (Reginaldo *et al.*, 2014) and there is still a need to conduct more surveys in many areas.

This study was conducted across noncontiguous habitats with varying levels of disturbances, namely, K'laja, General Santos City, Polomolok, South Cotabato and Malungon, Sarangani Province located

in Southern Mindanao, Philippines to determine if there are some small non-volant mammals that are endemic in each area and to assess the mammalian composition of the species with the recent studies. This provides additional records on geographic distributions of small mammals known to be indigenous across different sites in this area of Southern Philippines.

Materials and methods

Study sites

The 27-noncontinuous day sampling was conducted in the 30th of October to 17th of December 2015, in SOCCSKSARGEN. This region is located between mountain ranges and valleys that approximately gets an annual mean of 216.1 mm rainfall and has a high agricultural rate that supports diverse flora and fauna. The actual location was determined through Global Positioning System (GPS).

Site One

K'laja karst is located 15 km at the Northeast side of General Santos City, Barangay Conel. Its coordinates are 006.25912° N, 125.16706°E and is surrounded by towers of karsts formation made millions of years ago. Opposite to this area were the camping rounds of Nopol Hills which borders Conel and Barangay Mabuhay. Sampling was done on 30th of October to 7th of November 2015. Sampling was done in a lowland tropical forest that is in low elevated area. The forest layer is littered with thin layer of wet leaf litter with a thin sheet of humus substrate underneath. A large area of corn plantation dominates the area.

Site Two

Guaza Village, Polomolok is located 24.4 km away from General Santos City, South Cotabato with 6°18'36.4" N, 125°08'49.1 E coordinates. The sampling was done on the 15th to 23rd of November 2015. The sampling was conducted on a regenerating hill dipterocarp forest with a low elevated sloping terrain. Vegetation was dominated by coconut plantation and root crops.

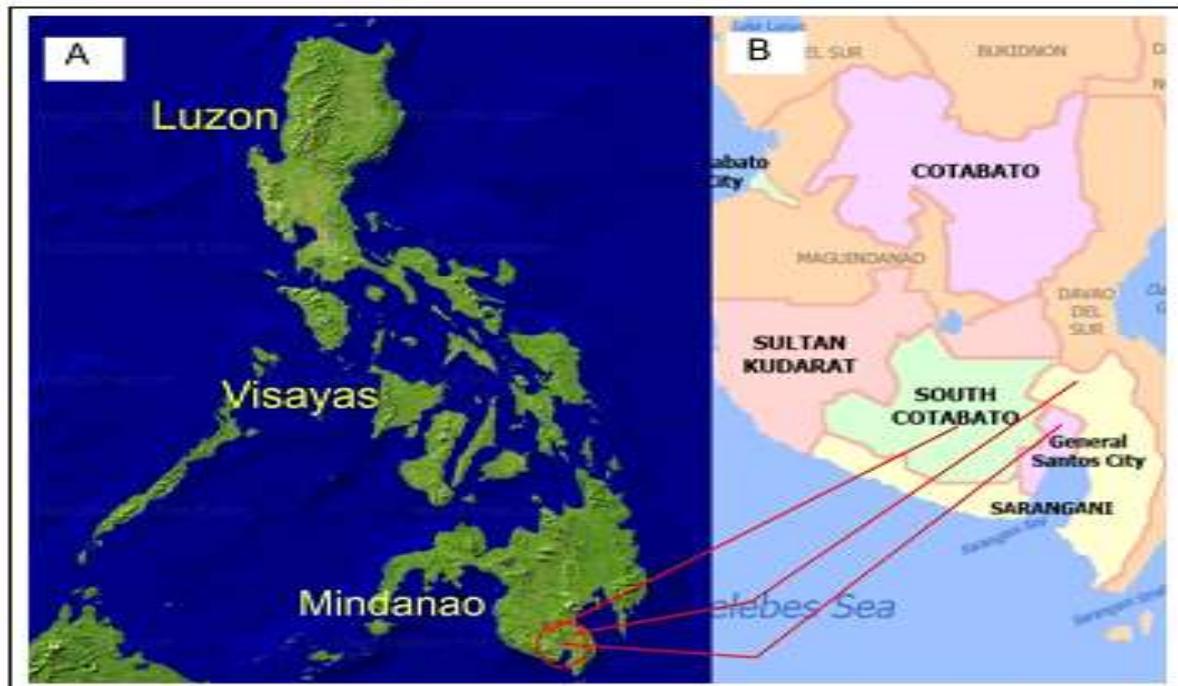


Fig. 1. Philippine Map (A) showing the different sampling areas, South Cotabato, Sarangani and General Santos City (B).

Site Three

Considered the most disturbed habitat out of all the three sites, Brgy. Upper Biangan, Malungon, Sarangani Province is located $6^{\circ}26'16''\text{N}$, $125^{\circ}14'24''\text{E}$ from General Santos City, South Cotabato. Sampling was done on the 9th to 17th of December 2015 and was conducted on low elevated area. Several settlements could be seen and the sampling site of the area is limited. Vegetation is dominated by rice plantation. Some habitants report of the huge increase of Muridae (rodents) in the area due to the construction of rice and corn mill.

Capture, Processing and Identification of Small Non-volant Mammals

The traps used to capture small non-volant mammals were limited to live Sherman traps. A 500-m transect line was used in the trapping procedure where 15m intervals are established that varied in length according to the slope of the terrain (with 15-35 capture stations). Each capture station was composed of 1 live-capture trap (Sherman® $7.6 \times 8.9 \times 22.9$ cm; H.B. Sherman® Folding Traps, Tallahassee, FL.) placed in between corners of corn mills and coconut.

Baits used were a mixture of peanut butter with coconut shredding, banana, rice and corn and the other bait is just corn. They were positioned in areas where rats may be present. The traps were placed strategically on 3 possible non-volant mammals infested areas: corn plantation, tropical forest patch and rice plantation.

With the help of local guides, the traps were baited and set on each of trapping session, checked the following morning to record captures, adjusted treadle sensitivity, and cleaned and rebaited traps as needed. Traps were left active 24 hours a day during each trapping session. Captured animals are collected twice each day, once in the morning (6:00 am to 7:00 am) and once in the afternoon (5:00 pm to 6:00 pm). The animals are properly handled according to their sizes and species.

All captured individuals were collected and measured based on its external measurements, mainly its tail, head, hind foot length and other external metrics, including total body length, snout, ears, front legs, weight, color and texture of the fur, and the position

of the pads in the soles of their feet. The identification is from the sampling guide of Lawrence Heaney and many others, entitled non-flying mammals of Mindanao Island, Philippines. Specimens that were captured, identified and measured were released on the site of capture.

Results and discussion

A total of 69 individuals of small non-volant mammals belonging to *Muridae* family with four genera and *Viverridae* family with only one genus were recorded in all sampling sites after 27 trapping nights (Table 1).

Table 1. Small non-volant mammals recorded in three different locations. The table shows the comparison of the type of species found in Polomolok South Cotabato, K'laja Karst General Santos City and Malungon, Sarangani Province.

Scientific name	English name	H	A	B	I	T	A	T	Total
		Polomolok, South Cotabato		K'laja Karst, Santos City		Conel, General Malungon, Sarangani Province			
<i>Apomys insignis</i>	Mindanao Montane Forest Mouse	10		2			-		12 (17.39%)
<i>Mus musculus</i>	House mouse	-		-			2		2 (2.90%)
<i>Rattus everetti</i>	Common Philippine forest rat	19		3			6		28 (40.58%)
<i>Rattus exulans</i>	Polynesian rat	4		1			-		5 (7.25%)
<i>Rattus argentiventer</i>	Rice field rat	-		-			11		11 (15.94%)
<i>Rattus tanezumi</i>	Asian rat	4		-			-		4 (5.80%)
<i>Tarsomys apoensis</i>	Long-footed rat	1		2			-		3 (4.35%)
<i>Paradoxurus hermaphroditus</i>	Common palm civet	4		-			-		4 (5.80%)
Over-all captures	trap	42 (60.87%)		8 (11.59%)			19 (27.54%)		69
No. of trap nights		9		9			9		27

There were eight species documented, Mindanao montane forest mouse (*Apomys insignis*), house mouse (*Mus musculus*), common Philippine forest rat (*Rattus everetti*), Polynesian rat (*Rattus exulans*),

rice field rat (*Rattus argentiventer*), Asian rat (*Rattus tanezumi*), long-footed rat (*Tarsomys apoensis*) and common palm civet (*Paradoxurus hermaphroditus*).

Table 2. Species evenness of all collected small non-volant individuals in Polomolok South Cotabato using the Shannon index.

POLOLOK	
Species	Species evenness
<i>Apomys insignis</i>	0.191
<i>Rattus everetti</i>	0.200
<i>Rattus exulans</i>	0.125
<i>Rattus tanezumi</i>	0.125
<i>Tarsomys apoensis</i>	0.050
<i>Paradoxurus hermaphroditus</i>	0.125
Total	0.816

Of all distributed non-volant mammals, only common Philippine forest rat (*Rattus everetti*) was distributed most widely because this species is generally known in Luzon especially in Mindanao and Polynesian rats (*Rattus exulans*) were the most limited in capture locations. The study found the presence of small non-volant mammals in these areas caused by the

vegetation type of the areas (Jalique *et al*, 2015) which is coconut and corn plantations and rice mills and the level of disturbance within the community. The presence and abundance of mammals is influenced mainly by forest productivity at the capture site and the productivity of the whole woodland (Niedziałkowska *et al*. 2010).

Table 3. Species evenness of all collected small non-volant individuals in K'laja karst, Conel, General Santos City using the Shannon index.

K'LAJA KARST	
Species	Species evenness
<i>Apomys insignis</i>	0.249
<i>Rattus everetti</i>	0.265
<i>Rattus exulans</i>	0.187
<i>Tarsomys apoensis</i>	0.249
Total	0.95

There were only two individuals of *Mus musculus*, three *Tarsomys apoensis*, four *Paradoxurus hermaphroditus* and four *Rattus Tanezumi* that were recorded in the study. This low count of capture can be noted by the inadequate number of live traps used, the ineffective bait made and the interruption within the insufficient sampling nights due to outpour of rain. Small non-volant mammals specifically rodents, are primarily nut and seed-eaters, and the bait used was peanut butter which is rich in calories, but it turned out to be counterproductive. This result coincides that native Philippine mammals are closely

associated with, and dependent upon their, natural forest habitat (Heaney *et al*, 1998), and this may be the reason that they are not lured because they are used to eating foods that can be found in their area. In addition, mammalian species richness decreases with rainfall (Start *et al*, 2011) because climate is one of the most important predictor variables explaining mammalian species richness and abundance patterns (Novillo, *et al*, 2014). Moreover, *Rattus everetti* was found on all sampling areas because they can tolerate a range of habitat modifications (Heaney, *et al*, 2008).

Table 4. Species evenness of all collected small non-volant individuals in Malungon, Sarangani Province using the Shannon index.

MALUNGON	
Species	Species evenness
<i>Mus musculus</i>	0.081
<i>Rattus everetti</i>	0.124
<i>Rattus argentiventer</i>	0.108
Total	0.313

The four endemic species, of which three are Philippine endemic, *Apomys insignis*, *Paradoxurus hermaphroditus* and *Tarsomys apoensis* are captured in Polomolok and *Rattus everetti* which is endemic in Mindanao Faunal Region is captured in all sampling areas. The presence of these species in

these sampling sites can be ascribed to the dense vegetation (Heaney *et al*, 1995). These sites were at an elevation that is adjacent to fields of *Zea mays* (corn) and *Oryza sativa* (rice) which are known to aid in the foraging activities of the rodents (Anaeto, 2000).

The result coincides with the findings that *R. everetti* is found everywhere on agro-forest ecosystem because it can tolerate areas that have been disturbed, either by natural forces or by humans, *P. hermaphroditus* usually live in dense tropical forested habitats and agricultural areas where mature fruit trees grow and even alongside with humans with undisturbed vegetation like in Polomolok while *T. apoensis* occurs in montane and mossy forest

(Heaney, *et al*, 1998) just like *A. insignis* that reaches its largest abundance in montane but also occurring in disturbed forest (e.g., by low-level logging and natural disturbances such as landslides) and probably does not occur in human dominated areas such as agricultural areas and grasslands (Heaney, 2002) like Polomolok and K'laja. Moreover, the availability of food affects the diversity of mammals in tropical habitats (Miller, 1977).

Table 5. Species richness of all collected small non-volant individuals in Polomolok South Cotabato, K'laja karst General Santos City and Malungon, Sarangani Province.

Community	Number of species in each site
Polomolok, South Cotabato	6 (75%)
K'laja karst, General Santos City	4 (50%)
Malungon, Sarangani Province	3 (37.5%)

Of the eight species recorded, three are Philippine endemic and one Mindanao Faunal Region endemic. Having knowledge of the distribution of each species is important when dealing with continued fragmentation of primary forest habitats, population explosion, and forfeiture of ecosystem benefits (Bradshaw, 2008).

abundant in rice fields, grasslands, and plantations (Payne *et al.* 1985) like K'laja and is broadly commensal with humans and lastly, *Rattus tanezumi* commonly called an Asian rat, is commonly found in around villages and agricultural areas like Polomolok. These species are common in disturbed lowland and montane forest up to 1,800 m (Heaney *et al.* 2008).

The four non-endemic species; *Mus musculus*, commonly called a house mice tends not to be found in forests and is only found in a very wide range of man-made habitats including houses, farm outbuildings, and maintains wild populations in outdoor habitats such as arable land and pastures (Musser, *et al*, 1998) like that in Malungon, *Rattus exulans* commonly called Polynesian rats, are opportunistic species and exploit a variety of habitats including Polomolok and K'laja which has grassland and forests and other habitats (Dwyer, 1978) involving those created by humans, such as houses, granaries, and cultivated lands, provided that it has adequate food supplies and shelter.

The species evenness (Tables 2, 3 and 4) has a significant difference. The results indicate that K'laja Karst, General Santos City has achieved the highest species diversity index, followed by Polomolok, South Cotabato and lastly, Malungon, Sarangani Province. Considering the species diversity of the three communities, where Polomolok has six species, with *Rattus everetti* that numerically dominates the other five species and Malungon having three species with *Rattus argentiventer* that dominates the other two species, both areas have individuals that have highly apart intervals while it is only in K'laja, where the four species are more evenly represented.

These rats usually live below 1,000 m in elevation, where there is good ground cover and well-drained soil (Masaharu, *et al*, 2001), *Rattus argentiventer* commonly called rice field rat are found in habitats

K'laja has less variation in the relative abundance of species, thus considered to be more “even”, since greater evenness have greater species diversity than those communities, Polomolok and Malungon with more variation in relative abundance.



Fig. 2. Photos of some actual small non-volant mammal species captured. Data is insufficient due to unfortunate turn of events (i.e., Strong wind and rain, agitating captured civet cats, with only measurements as our data).

Species richness (Table 5) is simply the number of species present, and has its highest at Polomolok, South Cotabato because the area is tropical, a habitat with such forested mountaintops that has higher productivity (the amount of carbon fixed by photosynthesis per unit area per time) surrounded by arid land suitable for small nonvolant mammals to live and survive, followed by K'laja karst, General Santos City and lastly, Malungon, Sarangani Province.

Conclusion

The species diversity is low as well as endemism. Elevation does not directly influence the distribution of species but rather, it is the condition of the habitat on which they are dependent to, whether it may be pristine or disturbed, that has affected the rat species present. The presence of both four endemic and non-endemic species indicates that SOCCSKSARGEN is important for the protection of plants and natural resources because it's where animals are dependent of to survive especially endemic species. But there are also observed cases where these small non-volant mammals threat the environment that was mainly damaging the crops and plantations due to fast reproduction of these rodents. Results indicate the call to keep an eye on these endemic species and try to find facts about them, since small mammals are excellent bioindicators of forest condition according to Salibay and Luyon. Sampling in adjacent areas of SOCCSKSARGEN and other parts of Mindanao may result in more number of species since it contains almost 80% that are not found in some parts of the world.

Acknowledgement

The researchers would like to express their special thanks of gratitude to Mindanao State University, for supplying the essential data needed for the preparation of this paper. They would also like to thank the community people in K'laja, General Santos City, Malungon, Sarangani Province and Polomolok, South Cotabato who helped them a lot in their field works within the limited time frame.

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