INNSPUB

Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 10, No. 5, p. 1-13, 2017
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

Species richness and endemism of Anurans in Mt. Matutum protected landscape, South cotabato, Philippines

Olga M. Nuñeza[*1], Maria Luisa P. Non[2], Edna P. Oconer[2], Maximo C. Aljibe[3]

[1]*Department of Biological Sciences, Mindanao State University, Iligan Institute of Technology, Philippines*

[2]*Department of Biology, Mindanao State University, General Santos, Philippines*

[3]*Commission on Higher Education, Koronadal City, Philippines*

Article published on May 23, 2017

Key words: Endangered, Endemic, Frogs, Montane forest, Toads

Abstract

Anurans (frogs and toads) have high percentage of endemism in the Philippines. This study was conducted in six sampling sites of Mt. Matutum Protected Landscape (MMPL), South Cotabato to determine the species richness, diversity, and endemism of anurans. Cruising method was done at different elevations in disturbed and undisturbed sites of Mt. Matutum. Paleontological Statistics Software Package (PAST) version 3.06 was used to determine biodiversity indices and similarity index. Kruskal-Wallis test was also done. Thirteen species of anurans belonging to six families and eight genera with high percentage of endemism (76.92%) were documented. High species diversity with more or less even distribution was recorded in MMPL. Site 2, a disturbed montane forest had the highest species richness, diversity, and endemism. The Philippine endemic and vulnerable species, *Oreophryne anulata,* was the most abundant. Seven species of anurans are threatened (six vulnerable, one endangered) and are all endemic. Sites 3 and 6 had the highest similarity percentage (88%) as shown by the Bray-Curtis cluster analysis while Kruskal-Wallis test showed no significant difference between samples in disturbed and undisturbed sites. Conversion of forest to farmland and hunting were observed as the threats to the endemic and threatened anuran species in Mt. Matutum Protected Landscape. Results indicate the need to conserve the anurans of MMPL through the protection of habitats.

***Corresponding Author:** Olga M. Nuñeza ✉ olgamnuneza@yahoo.com

Introduction

Amphibians are one of the major constituents of the fauna of the forest floor (Watanabe *et al.,* 2005) with more than 6000 species worldwide (IUCN, 2015a) composed of the tailless anurans (frogs and toads), the legless caecilians, and the long-tailed salamanders and newts (Alcala *et al.,* 2006). They play diverse roles in our natural ecosystem and their decline may cause other species to become threatened or may undermine aspects of ecosystem function (Matthews *et al.,* 2002; Whiles *et al.,* 2006). In the Philippines, amphibians are diverse consisting of at least 108 species of which three species are caecilians (Gymnophiona) and 105 species are anurans (frogs and toads) with 80% endemism (Diesmos and Brown, 2011). The species count may increase in number with the application of genetic and lineage approaches to systematics (Alcala *et al.,* 2006) indicating that the country's amphibian diversity remains underestimated (Diesmos and Brown, 2011). The presence of forests, rivers, streams, lakes, swamps and other ecosystems which are the preferred habitats of most of the amphibian organisms contributed to the high amphibian diversity (Almeria and Nuñeza, 2013). However, these ecosystems which are natural habitats of the amphibians have been threatened by anthropogenic activities such as deforestation, swidden farming, and conversion of forest to farmlands (Myers *et al.*, 2000; Slingenberg *et al.*, 2009) which likely affect amphibian diversity. With these, nearly half of the Philippine amphibian species are threatened (Diesmos and Brown, 2011) of which one species is critically endangered, 18 species are endangered, and 29 species are of vulnerable status (Stuart *et al.,* 2008) due to habitat loss, alteration, and fragmentation (Brook *et al.,* 2003; Gallant *et al.,* 2007) which are the serious threats to many species (Diesmos and Brown, 2011). Hence, defining conservation priorities and protection are essential to minimize biodiversity loss (Brooks *et al*., 2006).

Anurans (frogs and toads) serve as biological indicators of the health of the environment due to their sensitivity to habitat changes and they are also the most threatened species (Fabricante and Nuñeza, 2012).

With these, many studies on anurans were conducted in the Philippines including those of Nuñeza *et al.* (2010) in Mt. Malindang, Nuñeza *et al.* (2012) in Mt. Diwata Range, Fabricante and Nuñeza (2012) on diet and endoparasites of some anurans in Mt. Sambilikan, Almeria and Nuñeza (2013) in Agusan Marsh, Relox *et al.* (2011) in Mt. Hamiguitan, Beukema (2011) in a disturbed forest fragment of Mt. Kitanglad Range, Warguez *et al.* (2013) in Mt. Kalatungan, and Belleza and Nuñeza (2014) in Sarangani Province and Lanao del Sur. Just a few years ago, two newly discovered species of forest obligate frogs belonging to genus *Platymantis* in the montane and mossy forests of Nacolod Mountain Range in Southern Leyte Province were recorded by the Department of Environment and Natural Resources (2012). Both species differ markedly from other known species of Philippine *Platymantis* and allied to two different species groups, the *Platymantis guentheri* group *and Platymantis hazelae* group. This is the first time that a *Platymantis* species belonging to the *hazelae* group has been discovered in the Mindanao faunal region. Despite many extensive studies and the new species discovered, there are still areas in the Philippines that have poor faunal surveys which lead to limited information on the diversity of anurans.

Mt. Matutum which is located in South Cotabatoon the Island of Mindanao is a protected landscape that was declared in 1995 and is also a tentative UNESCO world heritage site (UNESCO, 2006). However, the only recent published reports on the biodiversity of Mt. Matutum in South Cotabatoareby Garciano *et al.* (2014) on the species richness of spiders, Nuñeza *et al.* (2015) on the species diversity of bats, and Nuñeza *et al.* (2016) on reptile diversity. Other available information is the unpublished report of Ateneo de Davao University in 2011. Conduct of faunal surveys in Mt. Matutum is necessary considering the limited data on the diversity of species in Mt. Matutum .This study aimed to assess the species richness and endemism of anurans in Mt. Matutum Protected Landascape (MMPL), South Cotabato, Philippines.

Fig. 1. Study site (A) Philippine map highlighting South Cotabato (Villar, 2003), (B) Mindanao map showing location of Mt. Matutum (C) Top view of Mt. Matutum Protected Landscape (www.google.com.ph/maps, 2016).

Materials and methods

Sampling sites

The research was conducted in Mt. Matutum Protected Landscape, South Cotabato (Fig. 1). It is located in the southeastern part of Mindanao, encompassing South Cotabato, Sarangani, and General Santos City, and known as SOCCSKSARGEN region. Six samplings sites were surveyed of which three are disturbed sites that were established at three elevations representing the lowland dipterocarp, montane, and mossy forests while the other three sites are relatively undisturbed that were also established at three elevations. Table 1 shows a summary of habitat description of the six sampling sites in MMPL.

Sampling method

Anuran survey was done using the cruising method. Cruising method involves walking through the study area without predetermined path and searching for anurans in various microhabitats (Alcala, 2009).

Fallen logs, shrubs, tree holes, forest floor, shrubs, ferns and other various microhabitats of herpetofauna were searched. Sampling was done from 1800hrs to 2000hrs. Body weight and morphometrics of collected samples were taken. Anurans readily identified in the field were released.

Identification was based on Inger (1954), Brown and Alcala (1978; 1980), and photographic guide of Nuñeza (2012). Identification was verified by Dr. Arvin Diesmos of the Philippine National Museum. One to two voucher specimens of some species were deposited at the MSU-IIT Natural Science Museum.

Data analysis

Paleontological Statistics Software (PAST) version 3.06 was used to determine biodiversity indices and perform cluster analysis and Kruskal-Wallis test.

Results and discussion

Species richness and endemism

Thirteen species of anurans with 62 individuals belonging to six families and eight genera were documented (Table 2).

High species richness and number of individuals were recorded in site 2, a disturbed montane forest. The presence of small spring with water deposition in the site, the vegetation structure with varied understory plant and trees, and the thick leaf litter covering its forest floor could be the factors for the richness of species in the site. According to Chettri *et al.* (2011) the high richness and diversity of amphibians is attributed to varied microhabitats and ecological niches suitable for their existence.

Table 1. Tabulated description of the six sampling sites in MMPL.

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Location	Upper Linan, Tupi, South Cotabato	Glandang, Tupi, South Cotabato	Glandang, Tupi, South Cotabato	SitioKawit, Barangay Maligo, Polomolok, South Cotabato	SitioKawit, Barangay Maligo, Polomolok, South Cotabato	SitioKawit, Barangay Maligo, Polomolok, South Cotabato
Coordinates	-	6°21'4.1"N, 125°3'39.6"E	6°21'48"N, 125°4'15"E	6°20'39.4"N, 125°6'5.3"E	6°21'9.9"N, 125°4'15"E	6°21'21.1"N, 125°5'8.0"E
Elevation (meters above sea level)	500 to 800	1323 to 1370	1600 to 1714	987 to 997	1325 to 1339	1612 to 1719
Vegetation Type	Disturbed lowland mixed agricultural and secondary forest	Disturbed montane secondary growth forest	Disturbed mossy forest	Undisturbed lowland mixed agricultural and secondary forest	Undisturbed montane secondary growth forest	Undisturbed mossy forest
Leaf Litter (depth)	thin	1.5 inches thick	1 to 2 inches thick	thin	1.5 inches thick	more than 2 inches thick
Fallen logs	absent	absent	Abundant	absent	absent	absent
Type of Water Bodies	River and stream	small spring with water deposition in the pond	absent	Small riverine system	absent	absent
Dominant understory plants	"malaropit" (*Elaeocarpus* spp.)	"osmunda" (*Calamus ornatus*)	*Pteridium* sp	*Impatiens platypetala*	*Calamus ornatus*	"lagulo" (*Blechnum egregium*) and "pandanbaging" (*Freycinetia maxima*).
Dominant trees	"Buyo-buyo" (*Piper arborescens*)	"anislag" (*Securinega flexuosa*)	"igim" (*Dacrycarpus imbricatus*)	"anabiong" (*Trema orientalis*) and "buyo-buyo" (*Piper arborescence*)	*Securinega flexuosa*	"igim" (*Dacrycarpus imbricatus*)
Emergent trees	*Ficus ulmifolia* and *Erythrina subumbrans*	White Lauan (*Shorea contorta*)	"igim" (*Dacrycarpus imbricatus*)	"taluto" (*Pterocymbium tinctorium*)	"agoho del monte" (*Gymnostoma rumphianum*) and "igim" (*Dacrycarpus imbricatus*).	"igim" (*Dacrycarpus imbricatus*)
Epiphytes	absent	absent	ferns	absent	absent	absent
Bryophytes	absent	absent	absent	absent	absent	present
Fruiting trees	Durian trees *(Durio zibethinus),* coffee, and corn fields	Coffee (dominant)	Coffee	durian trees, squash vines, and corn	absent	absent

The presence of native vegetation in site 2 is favorable to anurans as it offers a humid environment necessary for their survival (*Lemckert et al.,* 2009;Almeria and Nuñeza, 2013) and the leaf litter in the sampling site is an important habitat feature for anurans (de Maynadier and Hunter, 1998).

Moreover, a landscape composed of a mosaic of forest and open habitats surrounding wetlands would hold the highest diversity of frog species (Gagne´and Fahrig, 2007) because water bodies and other moist locations are used by aquatic amphibians undergoing indirect development, and the ground cover of terrestrial habitats serve as microhabitats and constant foraging areas of anurans (Kardong, 1995).

Despite the disturbance in site 2, it still remained functionally stable due to the possible regeneration which is a natural ability of an ecosystem to recover as reported by Sinha and Heaney (2006). A study of Relox *et al.* (2011) also found high diversity of anurans in the montane forest of Mt. Hamiguitan which could be due to the riparian, ground, and arboreal strata as microhabitats for anurans, which are relatively prominent in montane forest and humid lower elevation forests which could also be the case in site 2. Most of the anuran species documented in MMPL were found in disturbed montane forest.

Furthermore, the disturbed sites had the highest number of anuran species (S=11) and endemic species (8) than undisturbed sites with eight species and six endemic.

Sampling sites 3 and 6 which are both mossy forests had the lowest species richness (S=2) which is due to the absence of water system and the high elevation of the site. According to Nuzzo and Mierzwa (2000), amphibian abundance is strongly influenced by the presence of water or aquatic habitat in an area. Elevation also affects the presence of species in a site because as elevation increases the species of amphibians also decreases (Malonza and Veith, 2012).

Table 2. List of anurans recorded in the six sampling sites of Mt. Matutum Protected Landscape.

Scientific Name	Common Name	Conservation Status (IUCN, 2015b)	Endemicity	Disturbed Sites			Undisturbed Sites			Total
				Site 1 Lowland Dipterocarp forest	Site 2 Montane Forest	Site 3 Mossy Forest	Site 4 Lowland Dipterocarp forest	Site 5 Montane Forest	Site 6 Mossy Forest	
Ceratobatrachidae										
Platymantis dorsalis (Duméril, 1853)	Common Forest Frog	LC	PE	0	0	0	0	1	0	1
Dicroglossidae										
Limnonectes leytensis (Boettger, 1893)	Small Disked Frog	LC	PE	0	0	0	1	0	0	1
Limnonectes magnus (Stejneger, 1909)	Giant Philippine frog	NT	NE	3	4	0	2	0	0	9
Megophryidae										
Megophrys stejnegeri (Taylor, 1920)	Southeast Asian Horned Toad	VU	PE	0	1	0	1	0	0	2
Microhylidae										
Kalophrynus pleurostigma (Tschudi,1838)	Black-spotted Narrow mouthed Frog	LC	NE	1	0	0	0	0	0	1
Oreophryneanulata (Stejneger, 1908)	Davao Cross Frog	VU	PE	0	3	5	0	4	4	16
Ranidae										
Hylarana grandocula (Taylor, 1920)	Big-eyed Frog	LC	PE	1	0	0	0	0	0	1
Rhacophoridae										
Philautus acutirostris (Peters, 1867)	Acute-snouted Tree Frog	VU	PE	0	3	4	0	2	3	12

	Philautus leitensis (Boulenger, 1897)	Leyte Tree Frog	VU	PE	0	10	0	1	0	0	11
	Philautus poecilius (Brown and Alcala, 1994)	Mottled tree frog	VU	PE	0	4	0	0	0	0	4
	Philautus surrufus (Brown and Alcala, 1994)	Malindang tree frog	EN	PE	0	1	0	0	0	0	1
	Philautus worcesteri (Stejneger, 1905)	Smooth-skinned Forest tree Frog	VU	PE	0	1	0	0	0	0	1
	Polypedates leucomystax (Gravenhorst, 1829)	White-lipped Tree frog	LC	NE	1	0	0	0	1	0	2
Total number of individuals					6	27	9	5	8	7	62
Total number of species					4	8	2	4	4	2	13
Total number of endemic species					1	7	2	3	3	2	10
Total number of species in disturbed sites								11			
Total number of species in undisturbed sites								8			
Total number of endemic species in disturbed sites								8			
Total number of endemic species in undisturbed sites								6			

Legend: PE- Philippine Endemic; NE- Non- Endemic; LC-Least Concern; VUL-Vulnerable; NT- Near Threatened; EN-Endangered.

This result is in agreement with the findings of Fernandez and Nuñeza (2007) that species richness and diversity of herptiles decrease as altitudinal range increases. The only two species found in sites 3 and 6 are both endemic, namely, *Oreophryne anulata* and *Philautus acutirostris*.

Table 3. Biodiversity indices in the six sampling sites in MMPL.

	Disturbed Sites				Undisturbed Sites				Overall Total
	Site 1 Lowland Dipterocarp forest	Site 2 Montane Forest	Site 3 Mossy Forest	Total	Site 4 Lowland Dipterocarp forest	Site 5Montane Forest	Site 6 Mossy Forest	Total	
Species	4	8	2	11	4	4	2	8	13
Individuals	6	27	9	42	5	8	7	20	62
Dominance	0.3333	0.2099	0.5062	0.161	0.28	0.3438	0.5102	0.245	0.1644
Shannon H'	1.242	1.788	0.687	2.013	1.322	1.213	0.6829	1.692	2.052
Evenness	0.866	0.7473	0.9938	0.6803	0.9473	0.8409	0.9898	0.679	0.5988

This partly explains why low species richness was recorded in sites 3 and 6whichare dominated by endemic species that commonly inhabit mossy forest at high elevation. According to Diesmos *et al.* (2004a; 2004b), *O. anulata*and *P. acutirostris*are common inhabitants of mossy forest which concurs with the location of these species in Mt. Matutum. Moreover, most of the endemic anuran species in the study are commonly concentrated in high elevation areas (1300-1720 masl) while the non-endemic species were commonly found in lowland forest (500-1000 masl). Swenson *et al.* (2012) also found that endemic amphibian richness was highest at 1000-1500 m elevation.

The most abundant anuran was the endemic species, *Oreophryne anulata* with 16 individuals recorded. This frog was observed in sites 2, 3, 5 and 6 but none in sites 1 and 4. The said four sites are described to be montane and mossy forests, areas of high elevation ranging from 1000 masl to 1720 masl which are preferred habitats of small frogs like *Oreophryne anulata*.

Moreover, this species is also known to breed by direct development and does not require water for breeding (Diesmos *et al.,* 2004a) which is the case for sampling sites 3 and 6 where there were no aquatic system present in the area. Interestingly, *O. anulata* was absent in site 1, a disturbed lowland dipterocarp forest and site 4, an undisturbed lowland dipterocarp forest.

Table 4. Comparison between disturbed and undisturbed sites.

Test	Kruskal-Wallis Test		Interpretation
	H (chi ^{2})	P (same)	
Species Diversity	3.429	0.1801	No significant difference between samples
Evenness	4.571	0.1017	No significant difference between samples

This implies that endemic species like *O. anulata* prefers high elevation areas with low disturbance although Diesmos *et al.* (2004a) reported that this species can also be found in disturbed lower montane forest. The second in abundance was the endemic species *Philautus acutirostris* with 12 individuals recorded. This species was also found in sites 2, 3, 5 and 6 but absent in sites 1 and 4. This concurs with the finding of Diesmos *et al.* (2004a; 2004b) that just like *O. anulata, P. acutirostris* inhabits mossy and montane rainforests and breeds by direct development.

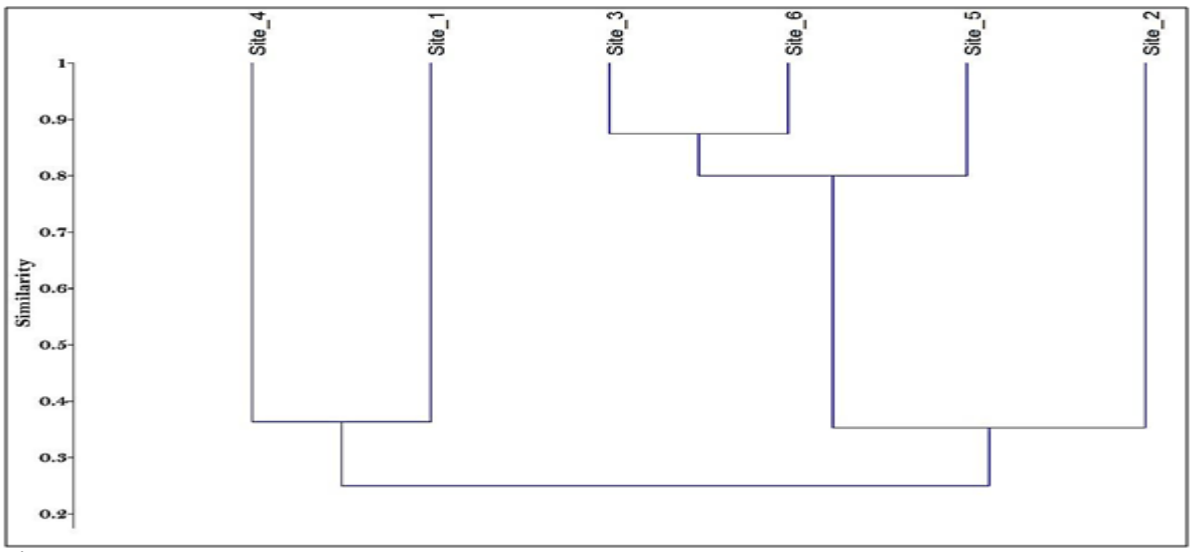

Fig. 2. Cluster analysis (Bray-Curtis) of anurans in the six sampling sites of Mt. Matutum.

Ten endemic anuran species with high percentage of endemism (76.92%) were documented. Site 2,a disturbed montane forest, had the highest number of endemic species (7 species) with 70% endemism. Diverse population of anuran species in the area is due to the presence of small pools of water, diverse composition of trees, understory plants, thick leaf litter cover, and cold environment contributing to the species endemism in the area. Anuran species usually dwell in areas with water and areas with high elevation where the air is humid enough to keep their body moist (National Resources Conservation Service, 2006). In addition, seven threatened anuran species were recorded in MMPL, of which six species

are under the vulnerable status and are endemic, namely, *Megophrys stejnegeri, Oreophryne anulata, Philautus acutirostris, Philautus leitensis, Philautus poecilius* and *Philautus worcesteri* while one species, *Philautus surrufus* is considered as endangered and endemic by IUCN Red List of Threatened Species (2015b). Continuous loss of habitat due to induced anthropogenic activities has contributed to the decline of the population of these species (IUCN, 2015b). However, the vulnerable species appears to be abundant in the area which only shows that Mt. Matutum Protected Landscape is providing shelter and protection to these currently vulnerable and endemic anuran species. Furthermore, it was observed that the disturbed sampling sites had the highest number of endemic species than the undisturbed sampling sites. This is due to the bodies of water which are present in the disturbed sites and varied vegetation that serves as foraging site of anurans.

Biodiversity Indices

Table 3 shows that site 2, a disturbed montane forest had the highest diversity (H'=1.788)among the sampling sites surveyed probably because the site is characterized by thick leaf litter, loamy soil, and presence of small spring which is preferred by anurans as their microhabitat and source of food. According to Relox *et al.* (2011), amphibians are diverse in montane forest and prefer areas with prominent water body structures and moist location such as stream and river for food sources and development. Ground cover and leaf litter also serve as microhabitat for amphibians (Kardong, 1995). Ngilangil *et al.* (2014) reported that food resource in an area is a contributing factor to species abundance as well as diversity. Moreover, Harvey *et al.* (2006) reported that tree cover and ground cover in forests are associated with higher animal species richness and abundance since they are likely to provide resources and habitat to the species originally present in the area than highly modified tree cover. Thus, this partly explains the diversity of anuran species in sampling site 2.

On the other hand, the disturbed sites showed higher total diversity value (H'=2.013) than the undisturbed sites (H'=1.692). Site 6 had the highest dominance index value of 0.5102 which implies that a dominant anuran species exists in this site (Cagod and Nuñeza, 2012; Soka *et al.*, 2013; Calimpong and Nuñeza, 2015). Furthermore, the more or less even distribution of anurans in MMPL could be due to the type of vegetation in the area, the degree of disturbance, the elevation, and the presence of microhabitat which serves as their hiding places from predators. This concurs with the observation of Ngilangil *et al.* (2014) that a more or less even distribution is likely caused by the same parameters such as elevation range, habitat type, and availability of food. Moreover, the evenness of the species in sampling sites is due to variation in geographical and physical factors (Bryant, 2002) since distribution of organisms includes the selection of habitats that provide the resources required for the survival of individuals of a particular species (Zug, 1993).

Similarity of sites

Fig. 2 is a cluster analysis showing the similarity of the six sampling sites in Mt. Matutum Protected Landscape. Sites 3 (disturbed) and 6 (undisturbed) formed the first clade with the highest similarity of 88% which means that these sites share mostly the same anuran species. Both sites 3 and 6 are mossy forests with dense leaf litter and almost having the same elevation. According to Tubelis and Cavalcanti (2001), sites having a great similarity percentage might have a similar type of habitat and have a tendency of having similar species composition. *Oreophryne anulata* and *Philautus acutirostris* are the two species shared by sites 3 and 6 where the most number of individuals of these species were observed. Diesmos *et al.* (2004a; 2004b) reported that these two species inhabit mossy forest and disturbed habitat adjacent to forest. Moreover, they stated that these species do not require water for breeding which concurs with the characteristics of sites 3 and 6 where these species were found.

Site 5, an undisturbed montane forest is clustered with sites 3 and 6 which are both mossy forests having 80% similarity. *O. anulata* and *P. acutirostris* are both found in these sites. Site 2, although a disturbed montane forest is clustered with sites 3, 5, and 6, due to the presence of *O. anulata* and *P. acutirostris* also in this site. Similarity, however, is low at 36%. *Philautus acutirostris* is an inhabitant of mossy and montane forests (Diesmos *et al.,* 2004b). This result concurs with the findings of Relox *et al.* (2011) that mossy and montane forests hold more similar amphibian species composition compared to lowland dipterocarp forest. The other clustered group was composed of sites 1 (disturbed) and 4 (undisturbed) with very low percentage similarity of 38%. Both sites have lowland dipterocarp forest where riverine system was found. However, only *Limnonectes magnus* was present in both sites. *L. magnus*isan inhabitant of undisturbed and disturbed streams and rivers in lower montane and lowland forests that breeds and deposits egg clutches in quiet side pools of forested riverine habitats (Diesmos *et al.,* 2004c).

There was no significant difference in terms of species diversity and evenness between disturbed and undisturbed sites (Table 4). This indicates that amphibian species in MMPL inhabit both disturbed and undisturbed sites.

Existing local threats in Mt. Matutum

Several threats to the biodiversity in Mt. Matutum were observed which include hunting and habitat loss due to conversion of forest to farm land. Hunting of wildlife in Mt. Matutum Protected Landscape appears to be a livelihood for some locals inhabiting the area. Conover (2001) reported that hunting of wildlife is considered a tradition for local people who have inhabited the area long enough but continuous hunting of wildlife may lead to the decrease in population of a certain group. This could also bring disturbance to other animals inhabiting the area which may cause them to flee from their respective habitat.

Moreover, conversion of forest to farm land is also one of the most common anthropogenic activities that affect the distribution of animals in many areas. Thus, the remaining habitat is not enough to support the population of a given species which causes the decline of population (National Resources Conservation Service, 2006).

Conclusion

Mt. Matutum Protected Landscape has low species richness of anurans (S=13) with high endemism (76.92%) and high anuran diversity (H'= 2.052). Among the recorded species, *Oreophryne anulata,* a Philippine endemic and vulnerable species was the most abundant and one of the most distributed species in MMPL. Disturbed sites have higher species, richness and endemism compared to undisturbed sites but had the most number of threatened anuran species. Seven threatened species of which six are vulnerable and one endangered which are all endemic were all found in the disturbed sites of MMPL indicating the need to strengthen conservation efforts in Mt. Matutum.

Acknowledgment

We acknowledge the Commission on Higher Education for funding this research, the DENR Region 12 for the issuance of Gratuitous Permit (GP), and Dr. Arvin Diesmos for the verification of the identification of the specimens.

References

Alcala EL. 2009. Land Vertebrates field Collection and Techniques (Mock training Version. Silliman University Angelo-king Centre for Research and Environmental Management (SUAKREM) Silliman University Dumaguete City, Philippines.

Alcala AC, Alcala EL, Buot LE, Diesmos A, Dólar M, Fernando ES, Gonzales J, Tabaranza B. 2006. Philippine Biodiversity: Ecological Roles, Uses, and Conservation Status. Transactions of the National Academy of Science and Technology, Philippines 28, 203-214.

Almeria ML, Nuñeza OM. 2013.Amphibian Diversity and Endemism in the Swamp Forests of Agusan Marsh, Agusan del Sur, Philippines. Advances in Environmental Sciences- International Journal of the Bioflux Society **5(1),** 30-48.

Belleza BGD, Nuñeza OM. 2014. Herpetofaunal Diversity and Endemism in Selected Caves of Sarangani Province and Lanao del Sur, Philippines. Advances in Environmental Biology **8(21),** 411-418.

Beukema W. 2011.Herpetofauna of disturbed forest fragments on the lower Mt. Kitanglad Range, Mindanao Island, Philippines. Salamandra **47(2),**90-98.

Brook BW, Sodhi NS, Ng PKL.2003. Catastrophic extinctions follow deforestation in Singapore. Nature **424,** 420–423.

Brooks TM, Mittermeier RA, Fonseca GAB, Gerlach J, Hoffmann M, Lamoreux JF, Mittermeier CG, Pilgrim JD, Rodrigues ASL. 2006. Global biodiversity conservation priorities. Science **313(5783),** 58–61.

Brown WC, Alcala AC. 1978. Philippine Lizards of the Family *Gekkonidae*. Silliman University. Natural Science Monograph Series 1.Dumaguete City, Philippines, 146

Brown WC, Alcala AC. 1980. Philippine Lizards of the family *Scincidae*. Siliman University. Natural Science Monograph Series 1.Dumaguete City, Philippines, pp. 264.

Bryant PJ. 2002. Biodiversity and Conservation: A Hypertext Book. School of Biological Sciences, University of California, USA.

Calimpong DMT, Nuñeza OM. 2015. Avifaunal diversity of Bega Watershed, Prosperidad, Agusan del Sur, Philippines. Journal of Biodiversity and Environmental Sciences **6(4),** 385-400.

Cagod BM, Nuñeza OM. 2012. Avian species diversity in oil palm plantations of Agusandel Sur and Compostella Valley, Philippines. Advances in Environmental Sciences- International Journal of the Bio flux Society **4(2),** 85-105.

Chettri C, Acharya BK, Bhupathy S. 2011. Chapter 13: An overview of the Herpetofauna of Sikkim with Emphasis on the elevational distribution pattern and threats and conservation issues. In: Biodiversity of Sikkim - Exploring and Conserving a Global Hotspot. Information and Public Relations Department Government of Sikkim, p. 233-254.

Conover MR. 2001. Effect of Hunting and Trapping on Wildlife Damage. Wildlife Society Bulletin **29(2),**521-532.

deMaynadier PG, Hunter MLJ. 1998. Effects of silvicultural edges on the distribution and abundance of amphibians in Maine. Conservation Biology **12,**350-352.

Department of Environment and Natural Resources (DENR).2012.New Species of Frogs Discovered in The Philippines- Forests of Southern Leyte a Critical Biodiversity Area. Retrieved from www.denr.gov.ph/news-and-features/latest-news/662-new-species-of-frogs-discovered-in-the-philippines-forests-of-southern-leyte-a-critical biodiversity-area.html.

Diesmos AC, Brown RM. 2011. Diversity, Biogeography and Conservation of Philippine Amphibians. In: Das I, Haas A, Tuen AA, Eds. Biology and Conservation of Tropical Asian Amphibians. Proceedings of the Conference "Biology of the Amphibians in the Sunda Region, South-east Asia" on September 28–30 2009.Universiti Malaysia Sarawak, Kota Samarahan, Sarawak, Malaysia, p. 26–49.

Diesmos A, Alcala A, Brown R, Afuang L, Gee G, Hampson K, Diesmos ML, Mallari A, Ong P, Ubaldo D, Gutierrez B. 2004a. *Oreophryne anulata*. The IUCN Red List of Threatened Species 2004: e.T57903A11697870. Downloaded on 19 February 2016.

Diesmos A, Alcala A, Brown R, Afuang L, Gee G, Hampson K, Diesmos ML, Mallari A, Ong P, Ubaldo D, Gutierrez B. 2004b. *Philautus acutirostris*. The IUCN Red List of Threatened Species 2004: e.T58809A11842665. Downloaded on 19 February 2016. http://dx.doi.org/10.2305/IUCN.UK.2004.RLTS.T58809A11842665.en.

Diesmos A, Alcala A, Brown R, Afuang L, Gee G, Iskandar D. 2004c. *Limnonectes magnus*. The IUCN Red List of Threatened Species 2004: e.T58353A11771100. Downloaded on 19 February 2016. http://dx.doi.org/10.2305/IUCN.UK.2004.RLTS.T58353A11771100.en

Fabricante KMB, Nuñeza OM. 2012. Diet and Endoparasites of *Rana granducula* (Amphibia, Ranidae) and *Limnonectes magnus* (Amphibia, Dicroglossidae) in Mt. Sambilikan, Diwata Range, Agusan Del Sur, Philippines. Advances in Environmental Sciences-International Journal of Bioflux Society **4(3),** 113-121.

Fernandez EV, Nuñeza OM. 2007. The reptiles of Mt. Tago Range, Bukidnon, Philippines: In: Proceedings 16th Annual Biodiversity Symposium. Wildlife Conservation Society of the Philippines. Ateneo de Davao University. April 2007. Wildlife Conservation Society of the Philippines, Quezon City, Philippines.

Gagne´SA, Fahrig L. 2007. Effect of landscape context on anuran communities in breeding ponds in the National Capital Region, Canada. Landscape Ecology **22,**205–215.

Gallant AL, Klaver RW, Casper GS, Lanoo MJ.2007. Global rates of habitat loss and implications for amphibian conservation. Copeia **4,** 967-979.

Garciano DMP, Nuñeza OM, Barrion-Dupo AL. 2014.Species Richness of Spider in Mt. Matutum, South Cotabato, Philippines. Journal of Biodiversity and Environmental Sciences **4(6),** 214-224.

Harvey CA, Medina A, Sanchez DM, Vilchez S, Hernandez B, Saenz JC, Maes JM, Casanoves F, Sinclair FL. 2006. Patterns of animal diversity in different forms of tree cover in agricultural landscapes. Ecological Applications **16(5),** 1986-1999.

Inger RF. 1954. Systematics and Zoogeography of Philippine Amphibia. Fieldiana Zoology **33(4),** 183-531.

IUCN Red List of Threatened Species.2015a. Amphibians. Retrieved February 19, 2016from www.iucnredlist.org/initiatives/amphibians.

IUCN Red List of Threatened Species. 2015b. The IUCN Red List of Threatened Species. Version 2015.4.<www.iucnredlist.org>. Downloaded on 19February 2016.

Kardong KV. 1995. Vertebrates: Comparative Anatomy, Function and Evolution. McGraw Hill, Columbus, Ohio, USA.

Lemckert F, Rosauer D, Slatyer C. 2009. A comparison of Australia's anuran recordsagainst the reserves system. Biodiversity and Conservation **18(5),** 1233-1246.

Malonza PK, Veith M. 2012. Amphibian Community Along Elevational and Habitat Disturbance Gradients in the Taita Hills, Kenya. Herpetotropicos**7,** 7-16.

Matthews KR, Knapp RA, Pope KL. 2002. Garter snake distributions in high-elevation aquatic ecosystems: is there a link with declining amphibian populations and non-native trout introductions?.Journal of Herpetology**36,** 16–22.

Myers N, Mittermeier RA, Mittermeier CG, da Fonseca GAB, Kent J. 2000. Biodiversity Hotspots for Conservation Priorities. Nature **403(6772),**853-858.

National Resources Conservation Service. 2006. Amphibians and Reptiles. Fish and Wildlife Habitat Leaflet, p. 1-8. Retrieved from www.fw.delaware.gov/Amphibians%20and%20Reptiles%20(WHC-N.

Ngilangil MM, Boyles LZ, Sularte RP. 2014. Abundance, Distribution and Conservation Status of Reptiles in Agusan Marsh, Bunawan, Agusan del Sur, Philippines. International Journal of Advances in Chemical Engineeringand Biological Sciences **1(2),** 2349-1507.

Nuñeza OM. 2012. Guide to Amphibians and Reptiles of Mindanao, Philippines. Office of Publication and Information OVCRE , Mindanao State University-Iligan Institute of Technology, IliganCity, Philippines, p. 1-72.

Nuñeza OM, Ates FB, Alicante AA.2010. Distribution of endemic and threatened herpetofauna in Mt. Malindang, Mindanao, Philippines. Biodiversity and Conservation **19(2),** 503– 518.

Nuñeza OM, Fabricante KM, Alicante AA, Sucaldito MP, Ponce AG. 2012. The Herpetofauna of Mounts Sambilikan, Ararat and Berseba of the Diwata Range, Agusan del Sur, Philippines. Asian Life Sciences **21(1),** 203-216.

NuñezaOM, Non MLP, Makiputin RC, Oconer EP. 2015.Species diversity of bats in Mt. Matutum protected landscape, Philippines. Journal of Biodiversity and Environmental Sciences **6(6),** 377-390.

Nuñeza OM, Non MLP, Oconer EP, Aljibe MC. 2016. Reptile diversity in Mt. Matutum Protected Landscape, South Cotabato, Philippines. Journal of Biodiversity and Environmental Sciences **8(2),** 9-21.

Nuzzo VA, Mierzwa KS. 2000. The Effect of Forest Structure on Amphibian Abundance and Diversity in the Chicago Region. Citizens for Conservation, U.S. Environmental Protection Agency, Great Lakes National Program Office, Lake County Forest Preserve District, Forest Preserve District of Will County, p. 1-29.

Relox RE, Leaño EP, Ates-Camino FB.2011.Herpetofaunal endemism and Diversity in Tropical Forests of Mt. Hamiguitan in the Philippines. Herpetological Conservation and Biology **6(1),**107-113.

Sinha CC, Heaney LR. 2006. Philippine Biodiversity: Principles and Practice. Studio graphics, Philippines, p. 53-56.

Slingenberg A, Braat L, van der Windt H, Rademaekers K, Eichler L, Turner K. 2009. Study on Understanding the causes Biodiversity loss and the Policy Assessment framework. Ecorys Research and Consulting, p. 1-199.

Soka GE, Munishi PKT, Thomas MB.2013. Species diversity and abundance of avifauna in and around Hombolo Wetland in Central Tanzania. International Journal of Biodiversity and Conservation **5(11),** 782-790.

Stuart SN, Hoffmann M, Chanson JS, Cox NA, Berridge RJ, Ramani P, Young BE. 2008. Threatened Amphibians of the World. Lynx Edicions, Barcelona, Spain; IUCN, Gland, Switzerland and Conservation International, Arlington, Virginia, U.S.A., 758 P.

Swenson JJ, Young BE, Beck S, Comer P, Córdova JH, Dyson J, Ember D, Encarnación F, Ferreira W, Franke I, Grossman D, Hernandez P, Herzog SK, Josse C, Navarro G, Pacheco V, Stein BA, Timaná M, Tovar A, Tovar C, Vargas J, Zambrana-Torrelio CM.2012. Plant and animal endemism in the eastern Andean slope: challenges to conservation. BMC Ecology **12**, 1.

Tubelis DP, Cavalcanti RB. 2001. Community similarity and abundance of bird species in open habitats of a Central Brazilian Cerrado. OrnitologiaNeotropical**12,** 57-73.

UNESCO. 2006. Mt. Matutum Protected Landscape. Retrieved from https://unescoworldheritage.silk.co/page/Mt.%20Matutum%20Protected%20Landscape%20%20Philippines

Villar EA. 2003. Map of the Philippines showing the location of South Cotabato. Retrieved February 19, 2016 from https://commons.wikimedia.org/wiki/File:Ph_locator_map_south_cotabato.png.

Warguez DA, Mondejar EP, Demayo CG. 2013. Frogs and their Microhabitat Preferences in the Agricultural and Secondary Forest areas in the Vicinity of Mt. Kalatungan Mountain, Bukidnon, Philippines. International Research Journal of Biological Sciences **2(10),** 51-63.

Watanabe S, Nakanishi N, Isawa M. 2005. Seasonal abundance in the floor-dwelling frog fauna on Iriomote Island of the Ryukyu Archipelago, Japan. Journal of Tropical Ecology**21,** 85–91

Whiles MR, Lips KR, Pringle CM, Kilham SS, Bixby RJ, Brenes R, Connelly S, Colon-Gaud JC, Hunte-Brown M, Huryn AD, Montgomey C, Peterson S. 2006.The effects of amphibian population declines on the structure and function of Neotropical stream ecosystems. Frontiers in Ecology and the Environment**4,** 27–34.

Zug GR.1993. Herpetology: An Introductory Biology of Amphibians and Reptiles. Academic Press Inc. San Diego, California, p. 1-527.