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Species richness and endemism of Reptilian Fauna in four Long-Term Ecological Research sites in Mindanao, Philippines

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ABSTRACT

Reptiles are highly sensitive to environmental change and are vulnerable to habitat disturbance. This study was conducted to determine the species richness and endemism of reptiles using the modified cruising method in 12 randomly selected plots inside a 1-hectare plot in four Long-Term Ecological Research (LTER) sites in Mindanao, namely: Mts. Apo, Kitanglad, Hamiguitan, and Malindang. Twenty-two reptile species belonging to eight families and 16 genera were documented in the four LTER sites. The level of reptile endemism was 64% where three out of 14 endemic species are found only in Mindanao. Mt. Hamiguitan had the highest species diversity (H'=2.4972) and species richness (n=18) with 11 (72%) endemic species, while the rest of the sites had very minimal number of species (n≤2). Among the recorded species, *Psammodynastes pulverulentus* had the highest number of individuals which was only recorded in Mt. Hamiguitan while the Philippine endemic, *Parvoscincus decipiens* was the most distributed species. Two threatened species, *Hydrosaurus pustulatus* and *Ophiophagus hannah* with vulnerable conservation status were recorded. Seriation analysis showed that high- elevation areas such as Mts. Apo and Kitanglad only host endemic and restricted species while Mt. Hamiguitan, a low-elevation forest, hosts endemic, non-endemic, and threatened species. Results suggest that the Mindanao LTER sites are good habitats for endemic and vulnerable species of reptiles and protection is needed.

KEY WORDS Conservation; Mt. Apo; Mt. Hamiguitan; Mt. Malindang; Reptiles.

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INTRODUCTION

The Philippines is one of the areas in the world considered as both a megadiverse country and a global biodiversity conservation hot spot (Hemphill et al., 1999). Its herpetofauna has a remarkably high diversity and endemism (Brown & Diesmos, 2009; Brown et al., 2013a). The Philippines houses not less than 270 species of reptiles with 74% endemism (Brown et al., 2013a). Habitat loss, invasive species, and hunting for food or wildlife trading threaten their diversity (Sodhi et al., 2004; Collen et al., 2009). Reptiles are sensitive to habitat changes (Tolhurst et al., 2016) and could serve as good environmental indicators, providing an excellent preliminary point for inventory and monitoring of biodiversity (Ngilangil et al., 2014).

Several areas in the country have been comprehensively characterized in terms of reptilian diversity which could provide baseline information. Such studies were conducted by Brown et al. (2013b) in northern Sierra Madre Mountain Range in Luzon where 72 reptile species were recorded composed of 30 lizards, 35 snakes, two freshwater turtles, three marine turtles, and two crocodilians. Brown et al. (2012) in Northern Cordillera Mountain Range recorded 34 reptile species (17 lizards, 16 snakes, and one turtle). Siler et al. (2011) documented 53 reptile species with new distribution record in the southern Sierra Madre Mountain Range. Despite efforts in the past in comprehensively characterizing reptilian fauna, there is still a need to conduct further studies (Brown et al., 2013b) which could lead to possible discovery of new species of reptiles. This applies as well to other areas in the country including Mindanao, the second largest island in the archipelago which has one of the largest remaining forest blocks in the Philippines (Relox et al., 2010; DENR, 2011; Morrison, 2016) where fewer studies on herpetofauna were done (David et al., 2006). In fact, two new species of morphologically cryptic monitor lizards, *Varanus dalubhasa* Welton, Travers, Siler et Brown, 2014 and *V. bangonorum* Welton, Travers, Siler et Brown, 2014 were described (Welton et al., 2014) and a new species of gecko from western Mindanao and the Sulu Archipelago was also described (Welton et al., 2010). Studies on reptiles, especially in forested areas of high elevation are desirable for these organisms function like anurans as bio-indicators to changes in the environment due to their high sensitivity to anthropogenic manipulation of habitat (Collen et al., 2009). Data on species richness of reptiles in certain forested areas in Mindanao include studies conducted by Nuñeza et al. (2006) who recorded 51 reptiles in Mt. Malindang, Rivera (2010) who reported 36 reptiles in Mt. Apo, Relox et al. (2010), and Delima et al. (2007) who recorded 15 and 19 species of reptiles, respectively, in Mt Hamiguitan. Moreover, Beukema (2011) recorded 12 species of reptiles in Mt. Kitanglad, Tariman & Warguez (2009) recorded 16 species of reptiles in Mt. Kalatungan Range, Balmores & Nuñeza (2015) recorded 16 species of reptiles with 81% endemic in the lowland forest of Prosperidad, Agusan del Sur, and Nuñeza et al. (2016) recorded 13 species of reptiles with 46% endemic in Mt. Matutum Protected Landscape. Habitat destruction was noted in these areas. Thus, clearance of forests, especially in montane forests which were documented to have notable records of reptile diversity, was found to be one of the major threats to the Philippine reptile species (Diesmos et al., 2002; Collen et al., 2009). In addition, habitat fragmentation and destruction and even climate change were found to cause herpetofaunal population decline (Alcala et al., 2012) which may lead to species extinction and biodiversity loss (Agarwal et al., 2005).

The ecological importance of reptiles cannot be underestimated for reptiles play essential components of the food web in most ecosystems as predators and preys (Klemens & Thorbjarnarson, 1995; Read & Scoleri, 2015). With the ultimate goal to conserve ecosystems and biodiversity even at global scales, Long Term Ecological Research (LTER) assists to address complex environmental challenges through comprehensive data system to the broader ecological community and other sectors (Amoroso, 2006; Magnuson, 2006). However, only few efforts were done in the Philippines as long term studies on various aspects of biodiversity (Alcala, 2006) and monitoring studies on Mindanao forest fauna especially reptiles in LTER sites are poorly known (Mohagan et al., 2015). This paper presents the updates on the species richness and endemism of reptiles in the four LTER sites in Mindanao.

MATERIAL AND METHODS

Study Area

One-hectare permanent plots were established as LTER sites in Mts. Apo, Hamiguitan, Kitanglad, and Malindang (Fig. 1). Tabulated description of habitats is shown in Table 1.

Samples

Modified cruising method was used to survey reptiles in 12 randomly selected plots, each having 20 m x 20 m dimension, inside the 1-hectare plot from 900 hours to 1400 hours. Microhabitats of reptiles such as forest floor, fern, tree branches, leaf litter, shrubs, trunks, soil, and holes were searched. Rotten logs, holes, and soil beneath rocks were dug using shovel and trowel to examine the presence of fossorial reptiles. Morphometric data were taken such as: total length (TL), snout to vent length (SVL), head length (HL), tail length (TL), forelimb length (FLL), and hindlimb (HLL) length using a vernier caliper. Scale counts on the head were done for the snakes only. Two to three individuals per species were collected as voucher specimens. Brown & Alcala (1978), Brown & Alcala (1980), and Alcala (1986) were used for preliminary identification. Identification of samples was confirmed by the third author. Conservation status of reptiles is based on the IUCN Red List of Threatened Species (2017).

Data Analysis

Diversity and evenness of reptile species were calculated using MS Excel 2010 while seriation analysis was done using Paleontological Statistics Software (PAST) version 3.04.

RESULTS AND DISCUSSION

Twenty-two reptile species with 50 individuals belonging to eight families and 16 genera were documented in the four LTER sites (Table 2). The result is relatively low compared to the survey conducted by Brown et al. (2012) in northern Cordillera Mountain Range and Brown et al. (2013b) in Sierra Madre Mountain Range. Compared to the study conducted by Tariman and Warguez (2009) in Mt. Kalatungan, Balmores & Nuñeza (2015) in Bega Watershed, and Nuñeza et al. (2016) in Mt. Matutum Protected Landscape, this result is relatively higher.

Among the sampling sites, Mt. Hamiguitan had the highest species richness (n=18) and abundance (39 individuals). The rest of the sites had very minimal number of reptilian individuals ($n \leq 7$) and species ($n \leq 2$). Situated at the lowest elevation gradient (1000-1100 masl) compared to the other three sites (1600-2200 masl), the high species richness of reptile fauna in Mt Hamiguitan could be attributed to its low elevation gradient. According to Diesmos et al. (2005) and Relox et al. (2010), reptile diversity declines as elevation increases specifically at cool higher elevations which concurred with the result of the study. The study of Relox et al. (2010) reported the same findings of

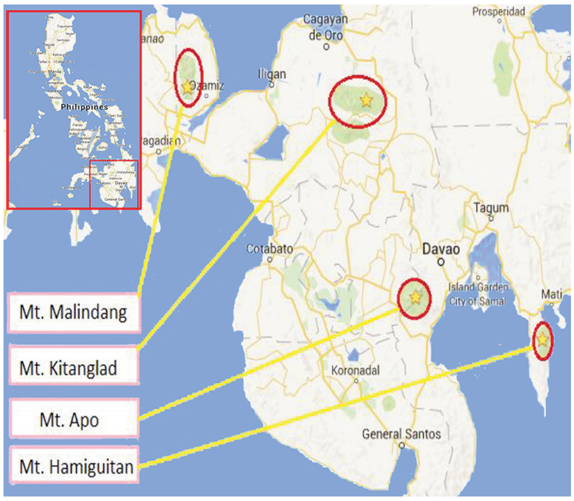

Figure 1. Map of Mindanao, Philippines showing the location of the four LTER sites (Google Maps, 2017).

higher abundance and species richness of reptiles in lowland dipterocarp forest in Mt. Hamiguitan than in upper elevations with notes on typical occurrence of reptiles in well-illuminated sites. Nuñeza et al. (2016) also found higher number of reptile species in the low-elevation areas of Mt. Matutum. Diesmos et al. (2005) reported that the lower elevations in Balbalasang-Balbalan National Park in Luzon (BBNP) support higher levels of reptile diversity and abundance, where at lower elevations the forests are hotter and drier. Compared to higher elevations, reptiles were less in abundance and species richness. In addition, low-elevation areas are also characterized by a large population of insects which could serve as food for reptiles (Angell et al., 2013). In the present study, records on temperature ranges among the LTER sites showed that Mt. Hamiguitan has a Tmin of 18 °C while the rest of the sites have Tmin of 9–14 °C. According to Brown et al. (2016), low-elevation areas which are characterized by dry and subarid biome consist of high species richness of reptiles. Palmer & Braswell (1995) reported that reptile occurrence is relatively low at higher elevations. Reptiles are known to use radiant heat sources or sunning opportunities as physiological requirement (Huey, 1982). McCain (2010) reported that on a global scale of reptilian diversity records, temperature is the factor most strongly correlated with the elevational reptile richness pattern.

LTER Sites				
	Mt. Apo	**Mt. Kitanglad**	**Mt. Hamiguitan**	**Mt. Malindang**
Coordinates	6°59′47′′N, 125°15′12′′E	8°5′46′′N, 124°55′17′′E	6°43′58′′N, 126°9′58′′E	8°17′45′′N, 123°36′34′′E
Elevation (masl)	1900 to 2000	2100-2200	1000-1100	1600-1700
Vegetation Type	upper montane forest	upper montane forest	lower montane forest	upper montane forest
Temperature (°C)	13-19	9-17	18-25	14-25
No. of sampling days	15 (November 15-18, 2012; February 5-10, 2013; and May 4-9, 2013)	14 (December 16-18, 2012; May 27-30, 2013; October 27-30, 2013; December 16-18, 2013)	12 (January 25-30, 2013; April 3-8, 2013)	17 (February 22-28, 2013; April 23-27, 2013; December 7-11, 2013)
Canopy layer at the site	(+), close type	(+), close type	(+),close to slightly open	(+),close to slightly open
Dominant flora	*Ascarina philippinensis* C.B. Rob., *Clethra canascens* Reinw. ex Blume, *Ardisia* sp., *Freycinetia* sp., *Sarcopyramis napalensis* Wall., *Elatostema* sp., *Hedyotis* sp. and *Ardisia japonica* (Thunb.) Blume, *Plagiogyria christii* Copel., *Alsophila heterochlamydea* R.M. Tyron, *Tmesipteris* sp.,	*Flacourtia* sp., *Prunus* sp., *Alsophila fuliginosa* H. Christ, *Mastixia trichotoma* Blume and *Phyllocladus hypophyllus* Hook.f., *A. japonica*, *S. napalensis*, *Agalmyla* sp., *Elatostema* sp. and *P. aduncum*, *Asplenium normale* D.Don, *Lycopodium clavatum* L., *Huperzia serrate*	*Syzygium* sp., *Palagium* sp., *Terminalia* sp., *Calophyllum blancoi* Planch. and Triana, and *Syzygium simile* (Merr.) Merr., *Freycinetia* sp., *Appendicula* sp., *Calamus* sp. cf *merrillii*, *Piper aduncum* L. and *Agalmyla* sp., *Selaginella involvens* (Sw.) Spring, *Oreogrammitis fasciata* Parris, *Lindsaea longifolia* Copel.,	*Hydrangea serratifolia* (Hook. and Arn.) Phil. f., *Macaranga dipterocarpifolia* Merr., *Eusideroxylon zwageri* Teijsm. et Binn., *Ficus odorata* (Blanco) Merr., *Justicia* sp. and *Pinanga philippinensis* Becc., *Impatiens platysepala* Y.L. Chen, *Freycinetia* sp., *P. aduncum*, *Gomphostemma javanicum* (Blume) Benth and *Elatostema* sp.,

Table 1/1. Habitat description of four Long-Term Ecological Research (LTER) sites.

	LTER Sites			
	Mt. Apo	**Mt. Kitanglad**	**Mt. Hamiguitan**	**Mt. Malindang**
	and *Lindsaea linearis* Sw.	(Thunb.) Rothm., *Acrophorus nodosus* C. Presl, *Hymenophyllum* sp., *Prosaptia* sp., and *Plagiogyria glauca* (Blume) Mett.	*Selliguea triloba* (Houtt.) ex M.G. Price and *Lindsaea hamiguitanensis* Karger, Lehtonen, Amoroso et Kessler.	*Selaginella tamariscina* (P. Beauv.) Spring, *Huperzia squarrosa* (G.Forst.) Trevis., *Asplenium decorum* Kunze, *Asplenium phyllitidis* D. Don, and *Araiostegia hymenophylloides* (Blume) Copel
Soil litter	thick and moist	thick to average	Moist	Absent
Type and distance to bodies of water	Stream was present at around 100-300 m from the site	Stream around 150-350 m from the plot was present	Running and stagnant water bodies were observed in some areas inside the plot and plot boundary, respectively	Stagnant rainwater was present near the plot and a stream was also present around 1000 m from the area
Distance to Anthropogenic Clearing	absent	absent	Absent	around 700-1000 m
Other description	Fallen trees and other plant species present	Fallen trees and other plants were present in moderate abundance	Fallen trees and other plant species of moderate abundance were present	Fallen trees and other plants were moderately present

Table 1/2. Habitat description of four Long-Term Ecological Research (LTER) sites.

Among reptiles, the most abundant species was the snake *P. pulverulentus* (n=10) occurring only in Mt. Hamiguitan. *Psammodynastes pulverulentus* was also documented in Bega Watershed (Balmores and Nuñeza, 2015), in Mt. Matutum (Nuñeza et al., 2016), in Subic Bay, Zambales Province (Devan-Song & Brown, 2012), in Mt. Kitanglad (Beukema, 2011), and on the ground on a stream bank and lower branches of a small bush on a river bank of northern Sierra Madre Mountain Range (Brown et al., 2013b). Skinks are second in terms of abundance as represented by *S. acutus* (n=7) and *S. variegatus* (n=3), which were both present only in Mt. Hamiguitan. *Pinoyscincus coxi* (n=4) was documented only in Mt. Apo and *P. decipiens*, the most widely distributed reptile species, was documented in Mts. Apo (n=3) and Hamiguitan (n=2). According to McLeod et al. (2011), Siler et al. (2011), and Brown et al. (2012), *P. decipiens* is a small-bodied forest species with a preference for intact, mid-to-high-elevation habitats which concurs on where this species was found in the study.

Fourteen endemic reptile species with 64% endemism were identified of which 11 species are Philippine endemic and three species are Mindanao endemic. Sampling sites that were located at higher elevations and far from anthropogenic activities had higher endemism. In the present study, Mts. Apo and Kitanglad had high percentage endemism (100%) while Mt. Hamiguitan had 61% endemism. Mts. Kitanglad and Apo are located at higher elevations (1900–2200 m asl) compared to Mts. Malindang and Hamiguitan (1000–1700 m asl). Diesmos (2005) reported that percentage endemism is much higher at high elevations as compared to low elevations especially at the montane and mossy regions since the species becomes more specialized for habitat adaptation. This supported the findings of this study on increasing percentage endemism of species as elevation increases. Ngilangil et al. (2014) stated that surveys targeted in higher elevations where there are less human disturbance could potentially have higher species endemism. Nuneza et al. (2010) found that endemic and threatened herpetofauna species were distributed in high elevation sites. Menegon et al. (2008) also reported that there is a positive correlation between endemism and elevation which shows that as elevation increases the percentage of endemicity also increases. Furthermore, no endemic species was documented in Mt. Malindang probably because of the anthropogenic disturbance near the area. According to Theisinger & Ratianarivo (2015), reptiles have a negative response to anthropogenic disturbances where individual numbers could decrease with increasing degradation.

All Mindanao endemic species in LTER sites were represented only by skinks such as *E. englei* and *T. partelloi*, each with one individual occurring only in Mt. Hamiguitan, and *P. kitangladensis* with two individuals only documented in Mt. Kitanglad. This finding showed the rarity of occurrence and abundance of geographically restricted species. Relox et al. (2010) also reported two species of Mindanao Island endemic reptiles such as *Oligodon maculatus* and *E. englei* where both were noted to occur only at higher elevation vegetation. This study thus presented a probable additional record of occurrence of Mindanao endemic reptile species in Mt. Hamiguitan as represented by *T. partelloi*, and *P. kitangladensis* in Mt. Kitanglad which was also documented previously by Beukema (2011), along with other reptiles such as *Draco cyanopterus* (Peters, 1867), *D. guentheri* (Boulenger, 1885), *S. mindanensis* (now *P. mindanensis* Taylor, 1915), *T. misaminius* (Stejneger, 1908), *T. partelloi*, and *Cyclocorus nuchalis* (Taylor, 1923). In Mts. Apo and Malindang, there were no Mindanao endemic species documented in this study. Rivera (2010) also noted the same findings in Mt. Apo. However, Nuñeza et al. (2006) previously documented two Mindanao endemic species in Mt. Malindang. Thus, habitats of restricted-range species are important and the need to protect the habitats (Nuñeza et al. 2012).

Among the reptile families recorded in this study, Colubridae and Elapidae were not represented by any endemic species. The rest of the families such as Agamidae, Natricidae and Calamaridae (50%), Scincidae (90%), and Viperidae and Gekkonidae (100%) were represented with certain number of endemic species.

Two species of reptiles, both documented from Mt. Hamiguitan only, were noted to have vulnerable conservation status, namely: *Hydrosaurus pustulatus*, a Philippine endemic species and *Ophiophagus hannah*. According to Ledesma et al. (2009), *H. pustulatus* is a semi-aquatic species that is generally restricted to riparian vegetation present in lowland tropical moist forests (both primary and secondary) which characterized the site where this species was found in this study. On the other hand, *O. hannah* is very rare in much of its range (Stuart et al. 2012). Rivera (2010) also reported the occurrence of *H. pustulatus* in Mt. Apo, along with vulnerable reptile species, the Southeast Asian Box Turtle, *Cuora amboinensis* (Daudin, 1802). Beukema (2011) and Brown et al. (2012) documented *C. amboinensis* in Mt. Kitanglad and in Northern Cordillera Mountain Range, respectively. Siler et al. (2011) also recorded *H. pustulatus* in the branches suspended over a river and *O. hannah* on the surface of the forest floor in secondary-growth forest of Sierra Madre Mountain Range. In addition, *O. hannah* is also reported to be widespread in Luzon area (McLeod et al. 2011; Devan-Song and Brown, 2012). Relox et al. (2010) noted no reptile species of threatened conservation status in Mt. Hamiguitan. Nuñeza et al. (2006) and Nuneza et al. (2010) also reported no threatened reptile fauna in Mt. Malindang.

The 22 reptiles recorded in the four LTER sites comprised not less than 8.5% of the total number of reptiles in the Philippines. Comparing previous studies conducted in the four LTER sites or at areas nearby, the present study showed higher species richness record by 20% in Mt. Hamiguitan. But for Mts. Kitanglad, Malindang, and Apo, the record of this study represents only 16.67%, 1.9%, and 5.56% of the previous findings, respectively (Nuñeza et al., 2006; Rivera, 2010; Relox et al., 2010; Beukema, 2011). It can be observed that in this study, lesser number of field sampling days were spent in Mts. Malindang (n=17) and Hamiguitan (n=12) compared to the number of field days spent by Nuñeza et al. (2006) in Mt. Malindang (n=203), and Relox et al. (2010) (n≥21) in Mt. Hamiguitan. Beukema (2011) spent 12 field days in Mt. Kitanglad while this study spent 14 field days in the area. Rivera (2010) did not specify the number of field days conducted in Mt. Apo. The number of sampling days and the number of reptile species documented did not present any noticeable or stable pattern. A lot of factors might have influenced the results which could include conspicuous absence of some species during surveys. Similar outcome was attained by Brown et al. (2012) when they assessed the herpetofauna of the Northern Cordillera Mountain Range in which a number of species were conspicuously absent during their brief survey. They predicted that these species would be recorded during future surveys in the area, thus a need for continuous long term monitoring. Ngilangil et al. (2014) in Agusan Marsh who recorded only 11 species of reptiles suggested that this does not exactly indicate species decline as the surveys were encountered only for four months and thus could be due to the species being missed during sampling where some individuals are small, hiding on leaf litter, and camouflaged.

Figure 2 shows the seriation analysis of reptile species in the four LTER sites. Most of the reptile species were recorded in Mt. Hamiguitan, a lower montane forest, except the four species, namely: *P. coxi*, *P. aquilonius*, *P. kitangladnesis*, and *C. lum-*

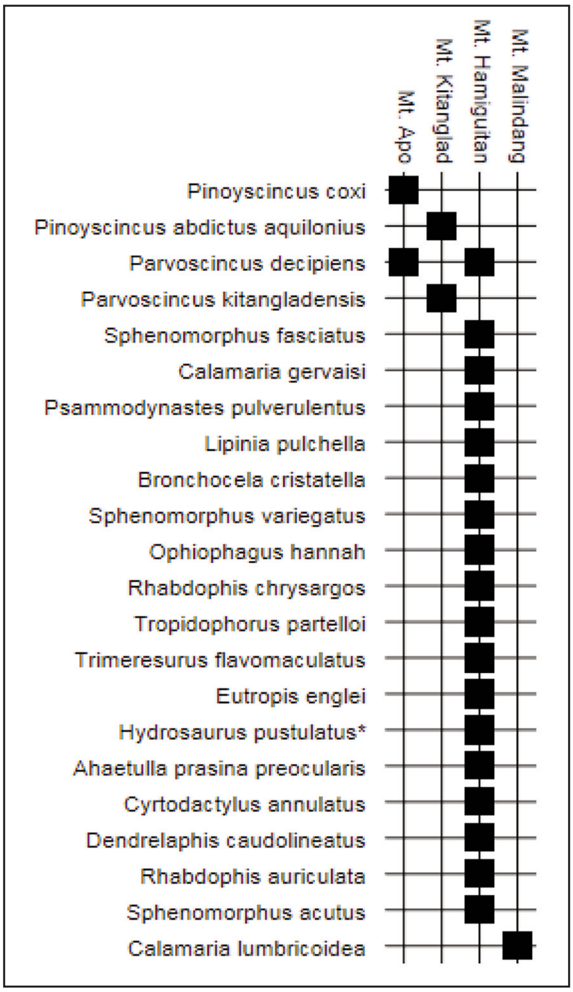

Figure 2. Seriation Analysis of reptile species in the four LTER sites.

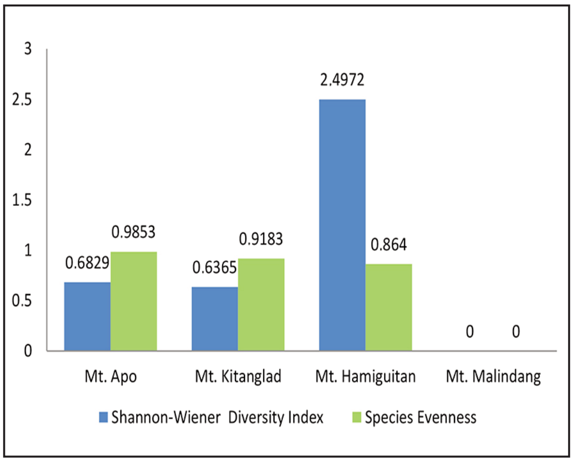

Figure 3. Shannon-Weiner Diversity Index and Species Evenness values of reptiles in the four Mindanao LTER sites.

Taxa	Distribution and Conservation Status	Mt. Apo	Mt. Kitanglad	Mt. Hamiguitan	Mt. Malindang
AGAMIDAE					
1. Green-crested Lizard *Bronchocela cristatella* (Kuhl, 1820)	NPE	0	0	1	0
2. Sailfin Water Lizard *Hydrosaurus pustulatus* (Eschscholtz, 1829)	PE (Vu)	0	0	1	0
CALAMARIIDAE					
3. Gervais' Worm Snake *Calamaria gervaisi* (Duméril & Bibron, 1854)	PE (LC)	0	0	1	0
4. Variable Reed Snake *Calamaria lumbricoidea* (H. Boie in F. Boie, 1827)	NPE (LC)	0	0	0	1
COLUBRIDAE					
5. Gunther's Whip Snake *Ahaetulla prasina preocularis* (Taylor, 1922)	NPE (LC)	0	0	1	0
6. Gray Bronze-back *Dendrelaphis caudolineatus* (Gray, 1834)	NPE	0	0	1	0
7. Common Mock Viper *Psammodynastes pulverulentus* (Boie, 1827)	NPE	0	0	10	0
ELAPIDAE					
8. King Cobra *Ophiophagus hannah* (Cantor, 1836)	NPE (Vu)	0	0	1	0
NATRICIDAE					
9. White-lined Water Snake *Rhabdophis auriculata* (Günther, 1858)	PE (LC)	0	0	2	0
10. Speckle-bellied Keelback *Rhabdophis chrysargos* (Schlegel, 1837)	NPE (LC)	0	0	1	0
GEKKONIDAE					
11. Small Bent-toed Gecko *Cyrtodactylus annulatus* (Taylor, 1915)	PE (LC)	0	0	2	0
SCINCIDAE					
12. Six-striped Mabouya *Eutropis englei* (Taylor, 1925)	ME (DD)	0	0	1	0
13. Yellow-striped Slender Tree Skink *Lipinia pulchella* (Gray, 1845)	PE (LC)	0	0	1	0
14. *Pinoyscincus abdictus aquilonius* (Brown et Alcala, 1980)	PE	0	1	0	0
15. Black-sided *Sphenomorphus Parvoscincus decipiens* (Boulenger, 1895)	PE	3	0	2	0
16. *Parvoscincus kitangladensis* (Brown, 1995)	ME (LC)	0	2	0	0
17. Pointed-headed Sphenomorphus *Sphenomorphus acutus* (Peters, 1864)	PE (LC)	0	0	7	0

Table 2/1. List of reptiles in four Long-Term Ecological Research sites in Mindanao. Legend: Vu (Vulnerable); LC (Least concern); DD (Data deficient); NPE (Non-Philippine endemic); PE (Philippine endemic), ME (Mindanao endemic).

Taxa	Distribution and Conservation Status	Mt. Apo	Mt. Kitanglad	Mt. Hamiguitan	Mt. Malindang
SCINCIDAE					
18. Cox's Sphenomorphus *Pinoyscincus coxi* (Taylor, 1915)	PE	4	0	1	0
19. *Sphenomorphus variegatus* (Peters, 1867)	NPE	0	0	3	0
20. Banded Sphenomorphus *Sphenomorphus fasciatus* (Gray, 1845)	PE (LC)	0	0	2	0
21. Partello's Waterside Skink *Tropidophorus partelloi* (Stejneger, 1910)	ME (LC)	0	0	1	0
VIPERIDAE					
22. Philippine Pit Viper *Trimeresurus flavomaculatus* (Gray, 1842)	PE (LC)	0	0	1	0
Total Number of Individuals		**7**	**3**	**39**	**1**
Total Number of Species		**2**	**2**	**18**	**1**
Total Number of Endemic Species		**2**	**2**	**11**	**0**
% endemism		**100%**	**100%**	**61%**	**0%**

Table 2/2. List of reptiles in four Long-Term Ecological Research sites in Mindanao. Legend: Vu (Vulnerable); LC (Least concern); DD (Data deficient); NPE (Non-Philippine endemic); PE (Philippine endemic), ME (Mindanao endemic).

bricoidea. In addition, all of the families recorded in this study were present in Mt. Hamiguitan while only one family (Calamaridae) in Mt. Malindang, and family Scincidae was only present in Mts. Apo and Kitanglad. Furthermore, only endemic and restricted species but not under threatened category were recorded in Mts. Apo and Kitanglad which are high elevation areas while a mix of endemic, non-endemic, and threatened species were found to be present in Mt. Hamiguitan and only non-endemic species (*C. lumbricoidea*) were present in Mt. Malindang. It was observed that the reptile species documented in this study are not widely distributed and thus occurring only in one or two sites.

In terms of diversity index, Mt. Hamiguitan had the greatest diversity of reptile species (H'=2.4972) compared to the other LTER sites which have very minimal number of species present ($n \leq 2$) resulting to low diversity in Mts. Kitanglad and Hamiguitan. Only one species of reptile was documented in Mt. Malindang resulting to zero diversity and species evenness values. The three LTER sites except Mt. Malindang have more or less even distribution of species (Fig. 3).

The result implies that Mt. Hamiguitan could be a more favorable habitat for reptile species which is characterized by close to slightly open canopy layer, low elevation, a relatively high temperature than the other sites, moist soil, fallen logs, and presence of running and stagnant water. High species diversity of reptiles was also observed by Ngilangil et al. (2014) in areas which are characterized by close canopy of trees with tall grasses, watery bed floor, adjacent to herbaceous-swamp, and suitable climatic conditions such as temperature. Nuñeza et al. (2016) also found high species diversity in the lowland areas of Mt. Matutum due to the relatively high temperature and the partially open canopy which are required by reptiles for thermoregulation. In addition, the high species diversity of Mt. Hamiguitan could be again supported by the findings of previous studies stating the preference of reptiles for low elevation areas secondary to their physiological requirement through basking on well-illuminated sites (Huey, 1982; Diesmos et al., 2005; McCain, 2010; Relox et al., 2010). But, this could also mean other reasons such as the possibility that Mt. Hamiguitan, a recently proclaimed UNESCO World Heritage site (UNESCO World Heritage Center, 2016), might be housing important natural resources which maintain their notable reptilian diversity. Moreover, the low diversity of species in Mts. Apo and Kitanglad could be due to their elevation and temperature because as Kryštufek et al. (2008) and McCain (2010) found that species diversity of reptiles gradually declines as elevation increases since temperature also decreases. Moreover, the more or less even distribution of species in Mts. Apo, Kitanglad, and Hamiguitan is caused by elevation range, habitat type, and availability of food (Ngilangil et al., 2014).

CONCLUSIONS

The four Mindanao Long-Term Ecological Research sites have a remarkable species richness and high endemism of reptiles especially in areas with elevation ranging from 1900 to 2200 m asl. The presence of vulnerable reptile species which includes one Philippine endemic implies the need for protection and conservation of the four LTER sites.

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