INNSPUB

International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print) 2222-5234 (Online)
http://www.innspub.net
Vol. 25, No. 2, p. 163-171, 2024

RESEARCH PAPER OPEN ACCESS

Species richness and endemism of anurans in lake Duminagat, Mt. Malindang range natural park, Mindanao, Philippines

Emmarie F. Mapi-ot[*1,2], Bobby B. Alaman[1], Jersam Calago[1], Yunalyn L. Villantes[2,3], Hanira B. Abubacar[2], Grace V. Villanueva[1]

[1]*Misamis University Community Extension Program, Misamis University, H.T. Feliciano St. Aguada, Ozamiz City, Philippines*

[2]*Natural Science Department, College of Arts and Sciences, H.T. Feliciano St. Aguada, Ozamiz City, Philippines*

[3]*Misamis University Research Center, Misamis University, H.T. Feliciano St. Aguada, Ozamiz City, Philippines*

Key words: Diversity, Endangered, Indicators, Threats, Vulnerable

http://dx.doi.org/10.12692/ijb/25.2.163-171 Article published on August 07, 2024

Abstract

Taking into account that amphibian, specifically Anurans (frogs and toads), are the most threatened group of vertebrates on the planet, a study of Anuran species diversity was conducted in Lake Duminagat, Mt. Malindang Range Natural Park, Misamis Occidental, Philippines. Anurans were collected using random sampling, and the visual encounter technique was used to determine the species richness of amphibians present in the area. With an initial goal of establishing an update about amphibian species diversity in this area, we conducted surveys that resulted in records documenting the occurrence of five species in five genera and five families. All the species (100 %) collected are endemic to the archipelago; these additionally include a Mindanao Faunal Region endemic, *Pulchrana grandocula* and one Mindanao Island endemic, *Ansonia mcgregori*. Among the recorded endemic species, two are classified as vulnerable to extinction. The mossy forest had highest species richness (N=4) and calculated species diversity (H'= 1.149) were recorded in the mossy forest. The presence of endemic and formally classified endangered species indicates the need to protect this forest ecosystem as an important habitat resource for endemic western Mindanao amphibian populations.

* **Corresponding Author:** Emmarie F. Mapi-ot ✉ efmapiot@gmail.com

Introduction

The Philippines, with over 7,100 islands, is the world's second biggest archipelago (Ambal *et al.*, 2012). It is also a megadiverse nation with a remarkably high endemism and species richness of amphibian species (Diesmos *et al.*, 2002a; Brown and Diesmos, 2009). Three caecilians (Gymnophiona; in a single genus and family) and frogs and toads (anurans) make up the Philippines' amphibian fauna, which includes about 112 species spread among 23 native genera and nine families (Brown *et al.*, 2012; Diesmos *et al.*, 2015). According to AmphibiaWeb (2024), as of 2023, 112 different species of anuran were found in the Philippines. More species are anticipated to be discovered in the upcoming years, especially in the surviving rainforests. Among the fauna, especially amphibians of which at least 97% is composed of anurans (frogs and toads) (Brown *et al.*, 2012), with possibly as much as 23% of the native amphibians being Mindanao endemics (Relox *et al.*, 2011; Diesmos *et al.*, 2015). The rich diversity of amphibians in the Philippines, recognized as a vital biodiversity hotspot globally (Abdullah *et al.*, 2023), is under imminent threat due to activities such as logging, urbanization, agricultural expansion, and environmental catastrophes.

One recent study in Rajah Sikatuna Protected Landscape, Bohol recorded 18 anurans species (Aureo and Decena, 2023). In Mt. Capistrano, 10 species of anurans were reported by Venturina *et al.* (2023). In caves of Caves and Limestone Forests in Southern Sierra Madre Mountain Range, Duco *et al.* (2023) recorded thirteen anuran species, including nine Philippine endemic.

In Bega Watershed of Agusan del Sur, 13 species of anurans were documented (Calo and Nuñeza, 2015); and in the wetland ecosystem in Agusan Marsh, 11 species (six of which were Philippine endemics) from six families have been reported (Sularte *et al.,* 2015). Brown (2015) described a new species of stream frog of the genus *Hylarana* (=*Pulchrana*) from Mt. Busa, Sarangani and South Cotabato provinces, southern Mindanao Island. Herpetological diversity of the southern Philippines remains incompletely documented, with new data adding to our understanding of the diversity on a regular basis (Brown *et al.,* 2013).

Protected areas (PA) are recognized solutions to combat climate change, forest degradation, and species extinction, which could threaten human beings (Naughton-Treves *et al.*, 2005). Protected areas (PAs) are acknowledged as effective measures to address climate change, prevent forest degradation, and mitigate the risk of species extinction, which poses potential threats to human well-being.

In Mindanao, Mt. Malindang Range Natural Park (MMRNP) is a proclaimed national park and is one of the key biodiversity areas in the Philippines (Ong *et al.*, 2002). This protected area (PA) is in the province of Misamis Occidental located in the Northwestern part of Mindanao, Philippines. It is renowned for its exceptional biodiversity and natural beauty, making it a significant ecological and cultural landmark in the country. Its unique and varied habitat types, such as the mossy forest at its peak, make it a home to several rare and endangered species. Several faunal biodiversity assessments have been conducted in the MMNRP, including Avifauna, Mammals, Odonata, Fishes, and various insect species (Nuneza *et al.*, 2006). Additionally, surveys on herpetofauna have been carried out in different mountain regions.

Lake Duminagat is one of the barangays within the protected area and was regarded with great interest for anuran surveys in Mt. Malindang. It is biologically significant as a water source for flora and fauna, as an area of high species diversity, and, in cultural terms, as a sacred place for the Subanen people (BRP, 2000). The high-altitude lacustrine ecosystem of Lake Duminagat is one of those comprising the diversity of ecosystems in Mt. Malindang.

In this study, we assessed the Anuran communities in Lake Duminagat, focusing on species composition, abundance, diversity, endemism, and threats to their community.

Materials and methods

Study site

Sampling was conducted on December 8-11 and February 10-17 in Lake Duminagat, Mt. Malindang Range Natural Park (Fig. 1). Lake Duminagat is a crater lake with an area of 8.04 hectares, a maximum depth of 20.95 meters, a water volume of 933,000 cubic meters, a mean depth of 11.6 meters, and a shoreline length of 1,060 meters. It is located in Barangay Lake Duminagat in the Municipality of Don Victoriano, Misamis Occidental, Mindanao Island, Philippines. Mt. Malindang Range Natural Park is a protected area in the Philippines with the highest elevation of 2,404 m.

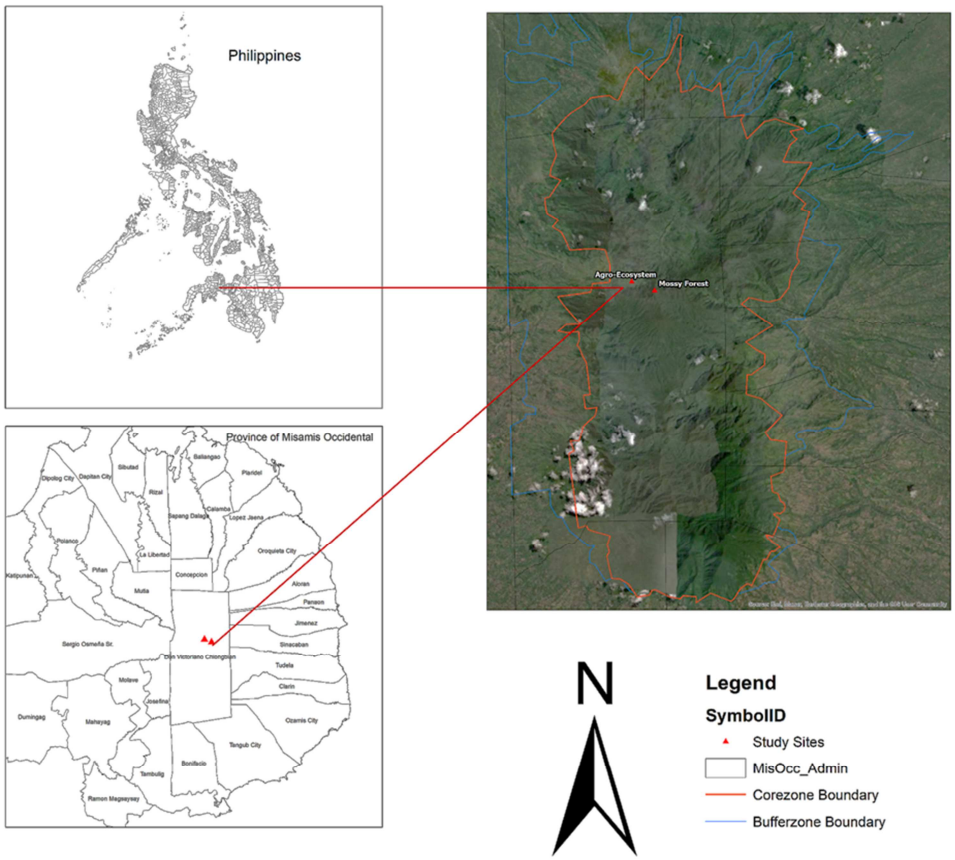

Fig. 1. Map of Mt. Malindang Range National showing the two sampling sites (red triangle); inset, map of the Philippines

Site 1 is an agroecosystem with an elevation of 1200 masl at 123°37'2.83" E 8°17'52.56"N, located near the community in Barangay Lake Duminagat. Dominant species include *Clethra lancifolia*, *Cyathea contaminans*, *Macaranga bicolor*, and *Adinandra montana* were the dominant species.

Site 2 is located in the mossy forest of North Peak with an elevation of 2, 204 masl at 123°37' 46.67" E 8°17'35.26" N. Dominant species *Syzygium sp.* (Polayo), *Dacrycarpus elatum* (Lumot), Polyosma Philippines (Babasa), *Euodia confusa* (Bintuko), *Cythea contaminants* (Gantaw), *Podocarpus lophatus* (Subing) dominated the site.

Sampling procedure

A visual encounter survey ("cruising") method was used to sample anurans from 1900 hours to 2200 hours. Our sampling effort was maximized, with several searches done in between and beyond this period, and resulting in a non-uniform sampling time for each site. Collected samples were identified based on the available field guides of Nuñeza (2006, 2012) and Alcala and Brown (1998). Morphometric

variables were measured using a vernier caliper, and body weight was taken using a spring balance. Samples that were identified in the field were marked and released. Voucher specimens were deposited in the Department of Natural Sciences, College of Arts and Sciences, Misamis University. The conservation status and geographical distribution of each anuran species were checked using the 2023 IUCN (International Union for Conservation of Nature) Red list of Threatened Species.

Statistical analysis

Biodiversity indices and other statistical analysis were determined using Paleontological Statistics (PAST) software. An ecosystem's diversity and relative abundance are considered by the index. Evenness measures the amount of if there are one or more individuals of each species in the area. The value is equal to one if species are numerous and equally diverse, and no species predominates over other species.

Results and discussion

Five species of Anurans belonging to the families Bufonidae, Dicroglossidae, Ranidae, Rhacophoridae, and Megophryidae were recorded in the two sampling sites (Table 1). The highest species abundance was recorded in the agroforest while the mossy area has 31.03%. Forest vegetation was composed of many plants and trees that created a wide range of canopy covers. The canopy cover may maintain temperature and moisture critical for the survival of the anurans and other amphibian species (Knapp *et al.,* 2003; Mapi-ot *et al.*, 2015). Amphibian assemblages in such natural landscapes may have a lower probability of local or metapopulation extinction than those positioned in disturbed landscapes, despite the elevated abundance of some species (Gray *et al.*, 2004). Mossy forest caters for more species compared to the agroforest. Structural habitat parameters are the best predictors of amphibian abundance and richness patterns with species richness highest in a forest habitat, and community composition differences between forests and disturbed habitats (Kudavidanage *et al.*, 2012). But Giaretta *et al.* (1999) reported that species richness and abundance of litter frogs in a montane forest of Southeastern Brazil was significantly associated with environmental parameters particularly at higher elevations where mist-generated humidity is notable and greater densities of frogs were found.

Table 1. Species composition, number of individuals, and relative abundance of amphibians in Lake Duminagat, MMRNP, Misamis Occidental

Number of individuals (Relative abundance in %)			
Anurans	Agroforest	Mossy forest	Total
Bufonidae			
Ansonia mcgregori	1(5.26)	2(22.22)	3
Dicroglossidae			
Limnonectes magnus	3(15.79)	5(55.56)	8
Ranidae			
Pulchrana granducola	15(78.95)	0	15
Rhacophoridae			
Philautus surrufus	0	1(1.11)	1
Megophryidae			
Megophrys stejnegeri	0	1	1
Total Number of Individuals	19(65.52)	9(31.03)	29
Total Number of Species	3	4	5

The lowest species richness was observed in Agroforest and this site is close to disturbance, agriculture, and human habitation. At the periphery of the area, human disturbances can be observed. The proximity of this site to an original forest may have accounted for the number of amphibians recorded. Brown and Alcala (1964) observed that the structurally simple non-forest communities, such as agroecosystems, could still support a significant population of herps if it is in proximity with other vegetation types, especially original or secondary-growth dipterocarp forest. Thus, it may be suggested that it was the proximity of this agroecosystem site to an original forest which enabled the forest species of amphibian to find suitable microhabitats in an otherwise non-forest community, that even many endemics, which were, in general, exclusively forest dwellers, were able to exist. Agricultural and land conversion has been shown negatively to affect amphibian species richness (Atauri and de Lucio, 2001). In addition to habitat loss, fertilizer and pesticide use in agricultural areas have been shown to affect the biodiversity and functioning of ecosystems

(Benton *et al.*, 2003). Species richness is lower in areas situated in agricultural and urban landscapes as compared to forested landscapes (Houlahan and Findlay, 2003).

Ansonia mcgregori was collected in all sites and commonly found above rocks covered with mosses. This species was reported from the Western Mindanao Pleistocene Aggregate Island Complexes or PAIC (Taylor, 1920; Brown and Alcala, 1970; Sanguila *et al.,* 2011), which includes the Mt. Malindang Range. The upstream area is in this mountain range's buffer zone.

Ansonia mcgregori is categorized ―Vulnerable (IUCN, 2023). The distribution of this species has been characterized as ―severely fragmented, and continuing decline in the extent and quality of its forest habitat in Mindanao has been extrapolated from forest cover reductions (IUCN, 2023) (Table 2).

Table 2. Habitat, geographic distribution, and conservation status of amphibian species in Lake Duminagat, MMRNP, Misamis Occidental

Anuran species	Common name	Habitat	Geographic distribution (IUCN, 2023)	Conservation status (IUCN, 2023)
Ansonia mcgregori	McGregor's Toad	Terrestrial, Freshwater	Mindanao Island Endemic	Least Concern
Limnonectes magnus	Giant Philippine Frog	Terrestrial, Freshwater	Philippine Endemic	Near Threatened
Pulchrana granducola	Big-eyed Frog	Terrestrial, Freshwater	Mindanao Faunal Endemic	Least Concern
Philautus surrufus	Molted Tree Frog	Arboreal, Terrestrial, Freshwater	Mindanao Endemic	Near Threatened
Megophrys stejnegeri	Mindanao Horned Frog	Terrestrial, Freshwater	Mindanao Island Endemic	Least Concern
Total of endemic species (endemism)			5 (100%)	

Philautus surrufus, a Mindanao endemic is also collected. This species can be found distributed in Mindanao Islands, particularly in Bukidnon, and Misamis Occidental, Mindanao, Philippines (Warguez *et al.*, 2013). The reproductive mode of these frogs is of the terrestrial development type (Alcala, 1962; Alcala and Brown 1982, 1998). Being direct developers, these frogs do not require streams or standing water to reproduce, thus, enabling them to successfully thrive in montane and mossy forests, which are otherwise uninhabitable to many other groups of frogs (Duellman and Trueb 1994).

We recorded low to moderate diversity in all the sampling sites (Table 3). Mossy forest has a higher species diversity (H'=1.149) than the agroforest (H'=0.633). Modifications of aquatic and terrestrial environments may have positively influenced the amphibian populations in agroforests. Although amphibians are highly forest-dwellers, the dense growth, however, of ferns, as well as the abundance of ground cover plants, such as sweet potato, yam, onion, seedlings, and bushes, could have provided adequate cover for these species, thus, enabling them to successfully thrive even in a non-forest area like the agroecosystem site of Lake Duminagat.

It was observed that all the collected Anurans are endemic. The Philippines' archipelagic terrain has resulted in to the emergence of distinct amphibian species on diverse islands, resulting in the endemic status of numerous amphibian species in the nation. Sampling areas that are located at higher elevations and farther from anthropogenic activities have higher endemism (Mohagan *et al.*, 2018).

The agroforest has a relatively low evenness, probably due to the abundance of *Pulchrana granducola* which dominates the site. *Pulchrana grandocula* is commonly found in streams and rivers in lower montane and lowland forests (Wilbert and Lagrosa, 2021). Some samples were

collected in streams pools, while majority were initially found perched on low lying vegetation on the creek bank. This observation is consistent with previous accounts of the preferred aquatic microhabitat of this species (Delima *et al.,* 2007; Plaza and Sanguila, 2015; Sanguila *et al.,* 2016). This species of frog is widespread across all elevations in several localities in Mindanao (Sanguila *et al.,* 2016). The differences in evenness of distribution may result from variation in community geographical and physical factors, given that the distribution of organisms involves selection of habitats, which provide the resources required for the survival of a particular species (Bryant, 2004).

Table 3. Biodiversity indices of amphibians in Lake Duminagat, MMRNP, Misamis Occidental

Biodiversity indices	Agroforest	Montane forest
Species Richness	3	4
Individuals	19	9
Dominance	0.651	0.3827
Shannon H'	0.633	1.149
Evenness	0.6278	0.7888

Conclusion

The notable species richness, abundance, high endemism of Anurans and the presence of vulnerable Philippine endemic and Mindanao endemic frog species in Lake Duminagat implies a need for conservation measures for species protection. Other parts of the Mt Malindang Range Natural Park, Misamis Occidental need to be surveyed to complete conservation assessments of amphibians within the protected area.

Acknowledgements

This output is part of the research project "Valuation of Forest Ecosystem Service of Mt. Malindang Range Natural Park " with funding support from DOST-PCAARRD implemented by Misamis University, Philippines. Sincerest thanks to the Protected Area Management Board of MMRNP for allowing the research team to conduct the study; PASu Angel P. Jumawan; RED Henry A. Adornado of DENR 10 for issuing Gratuitous Permit No. R10 2022-42; Subanen ICC/IPs in Misamis Occidental; and Dr. Karen Belina F. De Leon of Misamis University.

References

Abdullah SS, Dela Cruz KC, Casim LF, Agduma AR, Tanalgo KC. 2023. Leaping forward or crawling backward? Efforts and biases in amphibian and reptile research on a megadiverse faunal region in the Philippines. Conservation **3(3),** 363-378.

Alcala AC, Brown WC. 1982. Reproductive biology of some species of *Philautus* (Rhacophoridae) and other Philippine anurans. Kalikasan **11(2),** 203-226.

Alcala AC, Brown WC. 1998. Philippine amphibians: an illustrated field guide. Bookmark Inc., Makati City.

Alcala AC. 1962. Breeding behavior and early development of frogs of Negros, Philippine Islands. Copeia **,** 679-726.

Ambal RG, Duya MV, Cruz MA, Coroza OG, Vergara SG, de Silva NA, Molinyawe N, Tabaranza B. 2012. Key biodiversity areas in the Philippines: Priorities for conservation. Journal of Threatened Taxa**,** 2788-2796.

AmphibiaWeb. 2023. AmphibiaWeb. University of California, Berkeley, California, USA. Accessed 15 Dec 2023. https://amphibiaweb.org

Atauri JA, de Lucio JV. 2001. The role of landscape structure in species richness distribution of birds, amphibians, reptiles and lepidopterans in Mediterranean landscapes. Landscape Ecology **16,** 147-159.

Aureo WA, Decena SCP. 2023. Habitat alteration affects amphibian assemblages in Rajah Sikatuna Protected Landscape of Bohol, Philippines. Herpetological Conservation and Biology **18(2),** 348-361.

Benton TG, Vickery JA, Wilson JD. 2003. Farmland biodiversity: Is habitat heterogeneity the key? Trends in Ecology & Evolution **18(4),** 182-188.

Biodiversity Research Programme. 2000. Philippine-Netherlands Biodiversity Research Programme for Development in Mindanao: Focus on Mt. Malindang. Netherlands Development Assistance Research Council & SEAMEO Regional Center for Graduate Study and Research in Agriculture, Los Baños, Laguna.

Brown RM, Diesmos AC, Sanguila MB, Siler CD, Diemsos MLD, Alcala AC. 2012. Amphibian conservation in the Philippines. FrogLog **104,** 40-43.

Brown RM, Diesmos AC. 2009. Philippines, biology. In R. Gillespie & D. Clague (Eds.), Encyclopedia of Islands. University of California Press, Berkeley, California.

Brown RM, Siler CD, Oliveros CH, Esselstyn JA, Diesmos AC, Hosner PA, Linkem CW, Barley AJ, Oaks JR, Sanguila MB, Welton LJ. 2013. Evolutionary processes of diversification in a model island archipelago. Annual Review of Ecology, Evolution, and Systematics **44(1),** 411-435.

Brown RM. 2015. A new species of stream frog of the genus *Hylarana* from the mountains of southern Mindanao Island, Philippines. Herpetologica **71(3),** 223-233.

Brown WC, Alcala AC. 1964. Relationships of the herpetofauna of the nondipterocarp communities to that of the dipterocarp forest of southern Negros Island, Philippines. Senckenbergiana Biologie **45,** 591-611.

Brown WC, Alcala AC. 1970. The zoogeography of the herpetofauna of the Philippine Islands, a fringing archipelago. California Academy of Sciences.

Bryant PJ. 2004. Biodiversity and conservation. A hypertext book. School of Biological Sciences, University of California, Irvine.

Calo TJV, Nuñeza OM. 2015. Species richness and endemism of anurans in Bega Watershed, Prosperidad, Agusan del Sur, Philippines. Journal of Biodiversity and Environmental Sciences **7,** 1-14.

Delima EMM, Diesmos AC, Ibañez JC. 2007. The herpetological importance of Mt. Hamiguitan Range, Mindanao Island, Philippines. Banwa **4(1),** 27-40.

Diesmos AC, Brown RM, Alcala AC, Sison RV, Afuang LE, Gee GV. 2002. Philippine amphibians and reptiles: an overview of species diversity, biogeography, and conservation. Philippine biodiversity conservation priorities: A second iteration of the National Biodiversity Strategy and Action Plan, 26-44.

Diesmos AC, Watters JL, Huron NA, Davis DR, Alcala AC, Crombie RI, Afuang LE, Gee-Das G, Sison RV, Sanguila MB, Penrod ML. 2015. Amphibians of the Philippines, part I: checklist of the species. Proceedings of the California Academy of Sciences **62(20),** 457-539.

Duco RA, de Guia AP, Dimalibot JC, Parcon JA, Cosico EA, Malizon CR, Aguila AR, Alviola PA, Gonzalez JC. 2023. Terrestrial vertebrate diversity of caves and limestone forests in southern Sierra Madre Mountain Range, Luzon Island, Philippines. Philippine Journal of Science **152.**

Duellman WE, Trueb LS. 1994. *Biology of Amphibians*. The Johns Hopkins University Press, Baltimore. 670 pp.

Giaretta AA, Facure KG, Sawaya RJ, Meyer JD, Chemin N. 1999. Diversity and abundance of litter frogs in a montane forest of southeastern Brazil: Seasonal and altitudinal changes. Biotropica **31(4),** 669-674.

Gray MJ, Smith LM, Brenes R. 2004. Effects of agricultural cultivation on demographics of Southern High Plains amphibians. Conservation Biology **18(5),** 1368-1377.

Houlahan JE, Findlay CS. 2003. The effects of adjacent land use on wetland amphibian species richness and community composition. Canadian Journal of Fisheries and Aquatic Sciences **60(9),** 1078-1094.

IUCN. 2023. The IUCN Red List of Threatened Species. Version 2022-2. https://www.iucnredlist.org

Knapp SM, Haas CA, Harpole DN, Kirkpatrick RL. 2003. Initial effects of clearcutting and alternative silvicultural practices on terrestrial salamander abundance. Conservation Biology **17(3),** 752-762.

Kudavidanage EP, Wanger TC, De Alwis C, Sanjeewa S, Kotagama SW. 2012. Amphibian and butterfly diversity across a tropical land-use gradient in Sri Lanka; Implications for conservation decision making. Animal Conservation **15(3),** 253-265.

Mapi-ot EF, Bendoy CP, Palacio MMDS. 2015. Species richness and endemism of amphibians along the riparian system of Clarin River, Misamis Occidental, Philippines. Journal of Multidisciplinary Studies **4,** 86-107.

Mohagan AB, Nuñeza OM, Diesmos AC, Escarlos Jr JA, Gracia Jr AG, Selpa EC, Baguhin LJ, Coritico FP, Amoroso VB. 2018. Anuran species richness and endemism in four long-term ecological research sites in Mindanao, Philippines. Asian Journal of Conservation Biology **7(2),** 83-91.

Naughton-Treves L, Holland MB, Brandon K. 2005. The role of protected areas in conserving biodiversity and sustaining local livelihoods. Annual Review of Environment and Resources **30(1),** 219-252.

Nuñeza OM, Ates FB, Alicante AA, Calizo-Enguito MR, Toledo-Bruno AG, Labajo YI, Dejarme SM. 2006. A Photographic Guide to Vertebrate Fauna of Mt. Malindang. The Philippine-Netherlands Biodiversity Research Programme for Development in Mindanao, SEAMEO SEARCA, College Laguna.

Nuñeza OM. 2012. Photographic Guide to Amphibians and Reptiles of Mindanao, Philippines. Mindanao State University–Iligan Institute of Technology (MSU-IIT), Philippines.

Ong PS, Afuang LE, Rosell Ambal RG, eds. 2002. Philippines Biodiversity Conservation Priorities: A Second Iteration of the National Biodiversity Strategy and Action Plan. DENR-PAWB, Conservation International, Philippines, Biodiversity Conservation Program, UP Center for Integrative Studies and Found for Philippine Environment, Quezon City.

Plaza JL, Sanguila MB. 2015. Preliminary report on the anurans of Mount Hilong-hilong, Agusan del Norte, Eastern Mindanao, Philippines. Asian Herpetological Research **6(1),** 18-33.

Relox RE, Leano EP, Ates-Camino F. 2011. Amphibian diversity and composition in selected agroecosystems in Mt. Hamiguitan, Davao Oriental, Philippines. Journal of Environmental Science and Management **14,** 40-49.

Sanguila MB, Cobb KA, Siler CD, Diesmos AC, Alcala AC, Brown RM. 2016. The amphibians and reptiles of Mindanao Island, southern Philippines, II: the herpetofauna of northeast Mindanao and adjacent islands. ZooKeys **(624),** 1.

Sanguila MB, Siler CD, Diesmos AC, Nuñeza O, Brown RM. 2011. Phylogeography and conservation implications of geographic structure of genetic variation and potential species boundaries in Philippine slender toads. Molecular Phylogenetics and Evolution **61(2),** 333-350.

Sularte RP, Boyles LZ, Calomot NH, Demetillo MT, Ombat LA, Ngilangil MC, Binag GM. 2015. Species distribution and abundance of amphibians in two vegetation types of Agusan Marsh, Philippines. Advances in Environmental Sciences **7(1),** 20-34.

Taylor EH. 1920. Philippine amphibia. Philippine Journal of Science **16(3),** 213-359.

Venturina RE, Diesmos ML, Maglangit EP, del Prado YL, Ordas JA, Fernandez JB, Dans MF, Warguez DA, Diesmos AC. 2023. Herpetofauna of Mount Capistrano, a fragmented limestone karst forest in Central Mindanao, Philippines. Philippine Journal of Science **152(6A),** 2031-2048.

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.

Wilbert AA, Lagrosa RJP. 2021. Distribution and diversity patterns of amphibian species in the Rajah Sikatuna Protected Landscape, Bohol, Philippines. Journal of Biodiversity Conservation and Bioresource Management **7(2),** 23-32.