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Anurans species diversity and composition along the elevational gradient of the Balinsasayao Twin Lakes Natural Park, Negros Oriental, Philippines

Wilbert A Aureo*[1], Reizl P. Jose[1], Tomas D. Reyes[1], Lilibeth A. Bucol[2]

[1] *Department of Forestry and Environmental Science, Bohol Island State University, Bilar Bohol, Philippines*

[2] *Negros Oriental State University, Dumaguete City, Philippines*

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Abstract

Different habitat structures occupies different composition of anurans species which can be useful in determining their specific habitat requirements and preferences. The study assessed anurans species composition and diversity along an elevational gradient of Balinsasayao Twin Lakes Natural Park, Negros Oriental, Philippines. A line transect (1km) was used in the study using opportunistic approach in the collection of anurans in the established transect line per site where this was done both in daytime and nighttime. The results showed that anuran species richness and diversity were considerably higher in the sub montane compared to the montane and lowland. There were five species of anurans (i.e *Platymantis negrosensis*, *Sanguirana acai*, *Rhacophorus pardalis*, *Fejervarya vittigera* and *Polypedates leucomystax*) inhabiting the sub montane area and were not found both in montane and lowland areas while *Kaloula conjuncta* was observed only in lowland area. Furthermore, the morphometric measurements indicated that frogs found in the submontane area were bigger compared to the same frogs found in the montane and lowland. Finally, a change in species composition was observed along the successional gradient where the number of species observed in montane, submontane and lowland areas were S=2, S=11, and S=7, respectively.

***Corresponding Author:** Wilbert A Aureo ✉ waureo@vsu.edu.ph

Introduction

Anurans are tailless amphibians whose life cycles include aquatic and terrestrial phases. They are found to inhabit a large variety of habitats and size, depth, physiochemical characteristics, resource availability, water quality, presence or absence of predators (Dey, 2010). They are highly sensitive and vulnerable to changes to habitat quality and are extremely sensitive to small changes in temperature and moisture because of their permeable skin and unshelled eggs (Cushman, 2006). There are at least 22 genera with 98 species that represents the family Anura. Recent surveys has added about 20 new species of frogs which makes it more vulnerable to extinction. According to IUCN (2015), about 40% of the population is decrease over the decade.

Philippine biodiversity is severely threatened by habitat loss, pollution, overexploitation (e.g., over-harvesting for commercial purposes, illegal wildlife trade), and introduction of invasive species (Heaney & Regalado, 1998; Mallari *et al.*, 2001; Ong *et al.*, 2002; Diesmos *et al.*, 2006). The large-scale destruction and fragmentation of the country's lowland dipterocarp forest (Kummer, 1992) have already had adverse impacts on flora and fauna. Balinsasayao twin lakes is a watershed and designated as a wildlife sanctuary that appears to be an ideal site for this study. The area has a secondary growth forest and has become established as an important site for research particularly in terrestrial ecology in Southeast Asia (Alcala and Brown, 1969). However, fraction of the forest is being cleared for subsistence farming and this fragmentation is a consequence of intense human pressure experienced in the tropics (Whitmore, 1997) that might subject to factors such as leading to species loss or restriction of population size (Turner and Corlett, 1996). In spite of the important role played by bats in tropical ecosystems, little is known about how they are affected by habitat fragmentation (Bernard and Fenton, 2003).

The combinations of natural and anthropogenic factors such as climate, geographic ranges and vegetation types (Cueto and Casenave, 1999) are considered to have a significant influence on anurans species distributions and diversity (Mallari, 2009). Therefore, the current study examines the composition and diversity of anurans along an elevational gradient of Balinsasayao Twin Lakes Natural Park (BTLNP)

Materials and methods

Study site

The site is a tropical rainforest located in Negros Oriental, Philippines (Fig. 1). It has an elevation that ranges from 650 – 900 m.a.s.l in the lake and extends to the "Guinsayawan" peak found southwest with an elevation of approximately 1750 m.a.s.l. Balinsasayao twin lakes is surrounded by patches of secondary and old growth forest and contains a maximum water surface area reaching 3.4 hectares in 2014 but reduced to only 1.3 hectares during dry season.

Sampling method

Fig. 1 presents the one (1) kilometer transects that were established in four sites. The sites were represented by areas that has different elevation. These sites were pre-determined based on the general description by Brown and Alcala (1961) as cited by Bucol *et al.* (2019). Anurans were collected at early morning 6:00 - 9:00 am and evening at 7:00 – 10 pm (Warguez *et al*, 2013) from April to May 2019. The Visual Encounter Survey was used to search high potential areas throughout the sampling sites. These are on the surface and under rocks, logs, trees, and other debris within each established transect.

Measurement of anurans morphometric

The following morphometric measurements were taken using a vernier caliper to the nearest centimeter to support identification of anurans to the species level following Alcala and Brown (1998) and Alcala (1996) as adopted by HARIBON Foundation guidelines for amphibians. Morphometric includes Snout-Vent Length (SVL), a measurement from the snout to the tip of the ventral part; Tibia Length (TBL), from the tibia to the tip of the phalanges (leg not straightened); Head Length (HdL), from the snout to the tympanum; Hind limb Length (HbL), entire length of the hind limb (straightened); Eye Diameter (ED), diameter of the entire eye; Tympanum Distance (TD), distance of tympanum from both ends and Head Breadth, from one shoulder to the other.

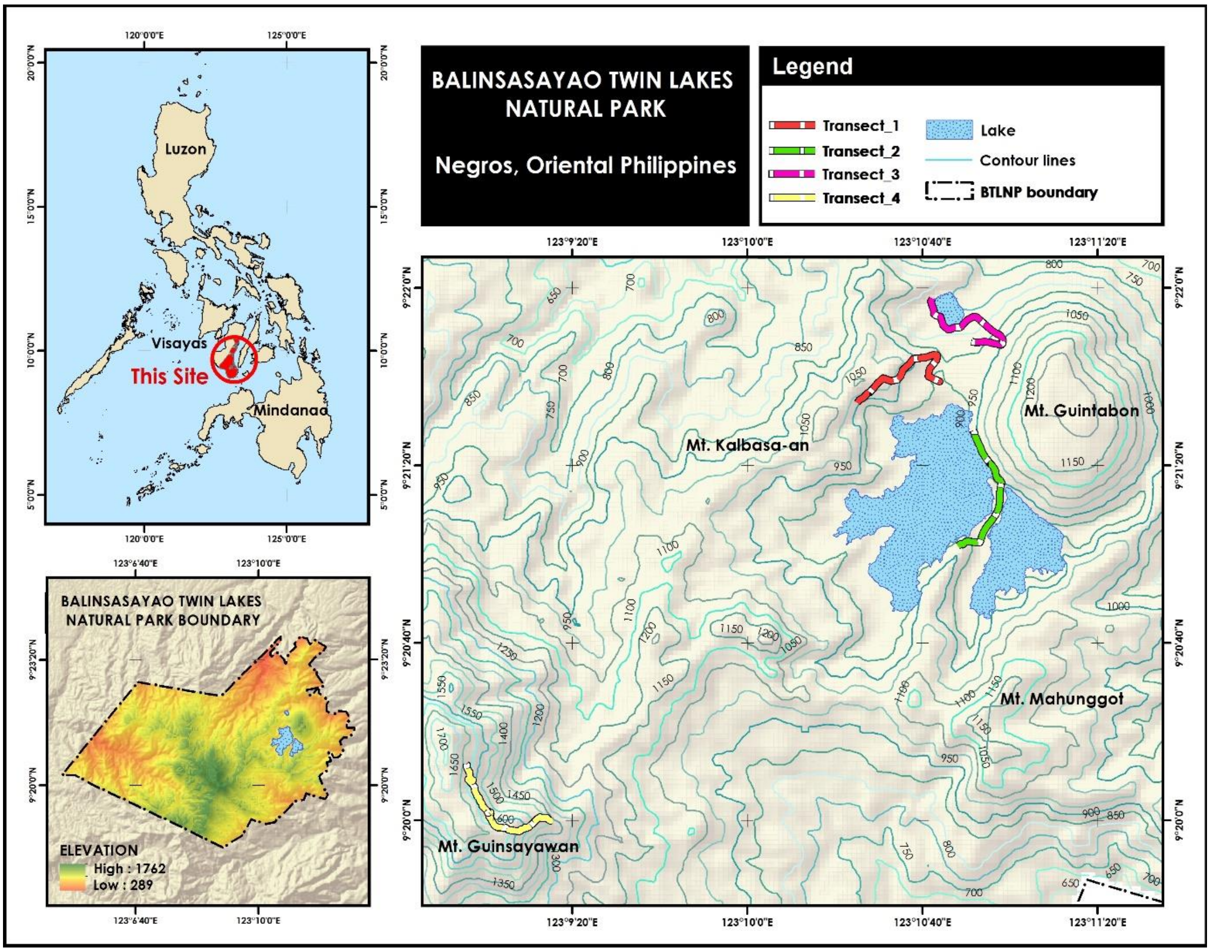


Fig. 1. Location of the study sites established within Balinsasayao Twin Lakes Natural Park (montane site labeled as transect 4, submontane sites as transect 1 (upper part of the lake) and transect 2 (along the lake), and lowland as transect 3.

Identification of anurans

The morphometric of each captured frog were measured. This was done in order to support the identification of anurans. Likewise, photographs of each captured anurans were taken using a digital camera. Pre-identification was done using the field guide of Diesmos and Alcala (2011) and IUCN List of Threatened Species. Moreover, photos and morphometric measurements were sent to an expert to confirm preliminary identification

Species diversity and richness

Species diversity and richness were calculated using the formula of Magurran (2004):

Species richness (S)

S = Total number of species Equation 1

Shannon diversity index (H')

$H' = \sum piLN\ pi$ Equation 2

Where:

H' – Shannon diversity index

pi – the proportion of individuals found in ith species (ni/N – normal estimator)

ln – normal log of data

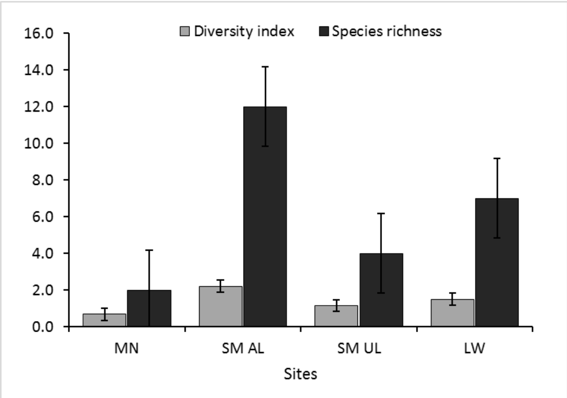
Statistical analysis

Species diversity and richness data were tested for normality and heterogeneity using PROC Univariate of Statistical Package for Social Science (SPSS) version 7.0. Least square differences (LSD) was carried out to compare means of independent variables with significant variations at $p \leq 0.05$ and express as standard errors.

Results and discussion

Anurans diversity and richness

Species richness (S) and diversity (H') is highest in the sub montane site along the lake with values of 12 and 2.21 respectively (Fig. 2). The high diversity and richness in the sub montane along the lake is because anurans tend to stay near lake banks to cool their body.



MN – Montane; SM (UL) – Sub montane, upper part of the lake; SM (AL) Submontane, along the lake; LW – Lowland

Fig. 2. Species diversity and richness of anurans observed in the sites.

Water is necessary for anurans metabolic processes and the increased metabolic rates associated with increased temperatures will raise water requirements. Increased temperatures will increase evaporation, which will require anurans to increase their water uptake (Bickford, 2005). Moreover the vegetation near the lake host a variety of insect species which serve as food for the anurans. On the other hand, lowest values (H'=0.67) and (S=2) are found in the montane portion of the natural park with an elevation of about 1750 m.a.s.l. The low values are due to the environmental conditions which are too extreme for some species of anurans. Only two species were observed thriving in this site. These are *Platymantis dorsalis* (Fig. 2B) and *Platymantis hazelae* (Fig. 2F) (Table 1).

Anurans composition along elevation gradient

There are a total of thirteen (13) species of anurans found in the study sites in which it constitutes six (6) families under eleven (11) genera (Table 1). Three of which are near threatened species and one is vulnerable under IUCN red list.

Table 1. Anurans species found in the different elevation gradient of BTLNP.

Elevation gradient	Family	Species	IUCN Status
MN	Ceratobatrachidae	*Platymantis dorsalis*	Least concern
	Ceratobatrachidae	*Platymantis hazelae*	Vulnerable
SM (UL)	Ceratobatrachidae	*Platymantis dorsalis*	Least concern
	Ceratobatrachidae	*Platymantis corrugatus*	Least concern
	Ranidae	*Hylarana erythraea*	Least concern
	Ceratobatrachidae	*Platymantis negrosensis*	Near threatened
SM (AL)	Ceratobatrachidae	*Platymantis dorsalis*	Least concern
	Ceratobatrachidae	*Platymantis corrugatus*	Least concern
	Ranidae	*Sanguirana acai*	Near threatened
	Dicroglossidae	*Occidozyga laevis*	Least concern
	Dicroglossidae	*Limnonectes visayanus*	Near threatened
	Ceratobatrachidae	*Platymantis hazelae*	Vulnerable
	Rhacophoridae	*Rhacophorus pardalis*	Least concern
	Dicroglossidae	*Fejervarya vittigera*	Least concern
	Rachoporidae	*Polypedates leucomystax*	Least concern
	Bufonidae	*Rhinella marina*	Least concern
	Ranidae	*Hylarana erythraea*	Least concern
LW	Ceratobatrachidae	*Platymantis dorsalis*	Least concern
	Ceratobatrachidae	*Platymantis corrugatus*	Least concern
	Ranidae	*Hylarana erythraea*	Least concern
	Dicroglossidae	*Occidozyga laevis*	Least concern
	Dicroglossidae	*Limnonectes visayanus*	Least concern
	Bufonidae	*Rhinella marina*	Least concern
	Microhylidae	*Kaloula conjuncta*	Least concern

MN – Montane; SM (UL) – Sub montane, upper part of the lake; SM (AL) Submontane, along the lake; LW – Lowland

These are *Platymantis negrosensis* (Fig. 2H), *Sanguirana acai* (Fig. 2C), *Limnonectes visayanus* (Fig. 2G) *and Platymantis hazelae* (Fig. 2F) respectively. Most of these species are found in the sub montane site along the river. The result of this study supports the findings of Bickford, (2005) that anurans tend to seek cooler microhabitat with lower temperature. Furthermore, several species of forest anurans are correlated with the quantity and quality of woody debris, litter depth, and over-storey canopy closure (deMaynadier and Hunter, 1995) which is also observed in the study site. The average morphometric measurements of *Platymantis dorsalis* (Fig. 2B), *Platymantis corrugatus* (Fig. 2A) and *Platymantis hazelae* (Fig. 2F) found in the submontane along the lake were bigger compared to the same species found in the other sites (Table 2). This could probably be that the species was affected by the change in temperature between sites that considerably altered the microhabitat of the anurans. This results support the findings of Feder and Gurggren (1992) that temperature affects the growth of anurans. This implies that the increase in temperature affects the development of larvae and embryos of anurans (Alvarez and Nicieza, 2002; Loman, 2002; Sanuy *et al*., 2008) along the lake. The increase in temperature was due to the differentiation of vegetation strata between the study sites and the distance from the lake. Moreover, *Platymantis negrosensis* (Fig. 2H) was only found in the sub montane upper portion from the lake. This species inhabits in tall trees with climbers, ferns and Pandanus species about 5-8 meters from the ground.

Table 2. Mean morphometric measurements of the four adult *Platymantis* species found in the sites.

Site	Species	Morphometric measurements (mm)						
		ED	TD	HdL	HB	SVL	TbL	HbL
MN	*Platymantis dorsalis*	5.00	4.00	14.85	13.10	39.60	25.85	72.20
	Platymantis hazelae	4.30	2.90	11.67	10.67	28.57	14.00	45.67
SM AL	*Platymantis dorsalis*	5.75	4.00	15.30	10.65	44.15	22.50	71.38
	Platymantis corrugatus	5.00	3.00	13.85	13.40	33.30	18.40	56.25
	Platymantis hazelae	4.38	3.20	10.68	10.50	28.63	12.88	44.25
SM UL	*Platymantis dorsalis*	5.00	6.00	16.57	14.93	28.27	16.93	61.00
	Platymantis corrugatus	4.90	2.85	4.20	10.10	20.85	11.00	56.95
	Platymantis negrosensis	4.90	3.10	12.70	12.10	31.00	16.50	39.90
LW	*Platymantis dorsalis*	3.67	2.80	14.97	8.20	31.50	20.33	57.97
	Platymantis corrugatus	4.27	2.57	6.30	8.73	21.57	10.67	49.37

*Eye diameter (ED), Tympanum distance (TD), Head length (HdL), Head breadth (HB), Snout-vent length (SVL); Tibia length (TbL) and Hind limb length (HbL)

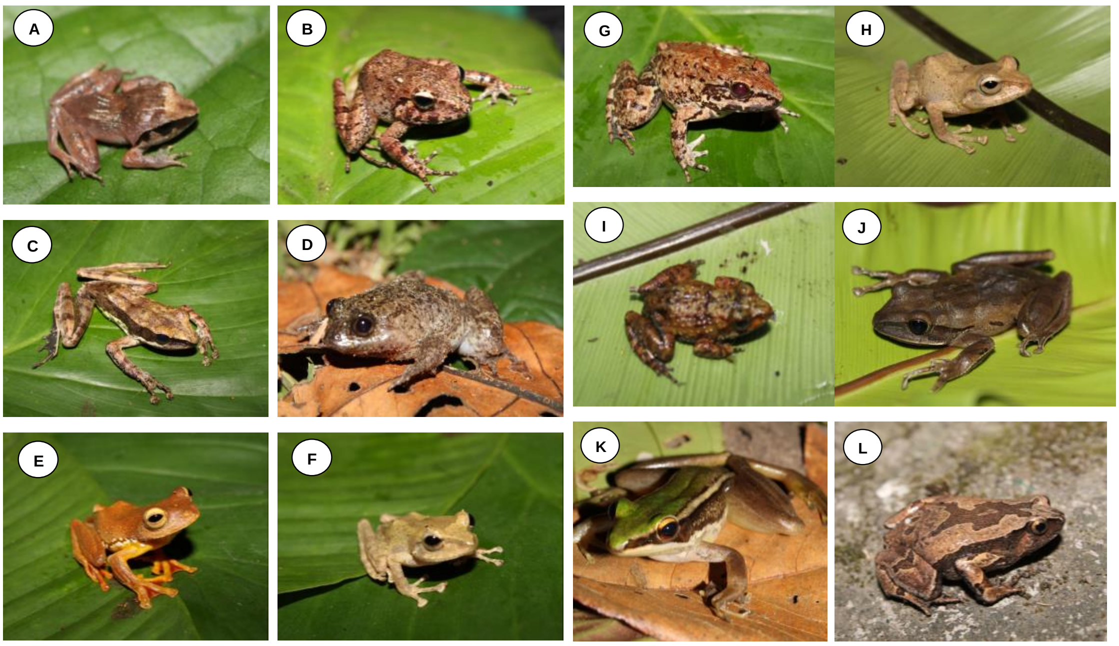


Fig 2. From left to right, *Platymantis corrugatus* (A); *Platymantis dorsalis* (B); *Sanguirana acai* (C); *Occidozyga laevis* (D); *Rhacophorus pardalis* (E); *Platymantis hazelae* (F); *Limnonectes visayanus* (G); *Platymantis negrosensis* (H); *Fejervarya vittigera (I); Polypedates leucomystax* (J); *Hylarana erythraea* (K); *Kaloula conjuncta* (L).

Conclusion

The results of the study shows that anuran species richness and diversity were considerably higher in the sub montane compared to the montane and lowland. It is worth noting that there was a change in species composition observed along the elevation gradient where the number of species observed in montane, submontane and lowland areas were S=2, S=11, and S=7, respectively. There were five species of anurans (i.e *Platymantis negrosensis*, *Sanguirana acai*, *Rhacophorus pardalis*, *Fejervarya vittigera* and *Polypedates leucomystax*) inhabiting the sub montane area and were not found both in montane and lowland areas while *Kaloula conjuncta* was observed only in lowland area. Furthermore, the morphometric measurements indicated that frogs found in the submontane area were bigger compared to the same frogs found in the montane and lowland. Thus, most species of anurans inhabit a wide range of habitat because of varying requirements and preferences.

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