



COMPARISON OF HERPETOFAUNAL DIVERSITY AMONG FOUR MAJOR ISLANDS OF BATANES PROVINCE, NORTHERN PHILIPPINES

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ABSTRACT – A comprehensive study of amphibians and reptiles (herpetofauna) using a variety of standard methods was completed at selected study sites on the islands of Itbayat, Batan, Sabtang, and Ivuhos in Batanes Province, Philippines. This paper reports a total of 19 species representing one frog (Family Rhacophoridae) and 18 species of reptiles for Batanes Group of Islands. Species richness is highest in both Batan and Sabtang (58%), followed by Itbayat (47%), and Ivuhos (32%). Endemicity is higher in Batan (26%) and Sabtang (21%) compared to Itbayat (11%) and Ivuhos (11%). In addition to the five Batanes reptilian endemics reported by previous workers, namely *Draco jareckii*, *Gekko porosus*, *Lepidodactylus balioburius*, *Trimeresurus mcgregori*, and *Lycodon alcalai*, we documented additional four new distributional records for the province. As a whole, isolation and relatively small cumulative area in Batanes group of islands are attributed to the limited representation of herpetofauna. However, its landscapes and habitat types serve as microhabitats to unique and geographically restricted species, making this group of islands an important area for herpetological endemism.

Keywords: Batanes Islands, herpetofaunal diversity, amphibians and reptiles, herpetological endemism

INTRODUCTION

The Batanes group of islands compose the smallest province of the Philippines in terms of population (16, 604 people) and land area (ca. 230 sq. km.). It is located about 162 km north of Luzon mainland and consists of ten islands and islets namely Itbayat, Batan, Sabtang, Siayan, Mavudis, Diogo, North Island, Y'ami, Ivuhos and Deguey (Figure 1). Batanes represents one of the distinct herpetofaunal regions in the Philippines, specifically referred to as Batanes Pleistocene Aggregate Island Complex (PAIC) (Diesmos, et al., 2002).

The Batanes islands are situated between Bashi Channel and Balintang Channel, where the Pacific Ocean merges with the West Philippine Sea (China Sea). Itbayat (95 sq. km.), Batan (35 sq. km.) and Sabtang (41 sq. km.) form the largest of the ten islands with Mount Iraya/Mount Irada (20°28'N12°201'E) in Batan Island as the highest peak at an altitude of 1,085 masl.

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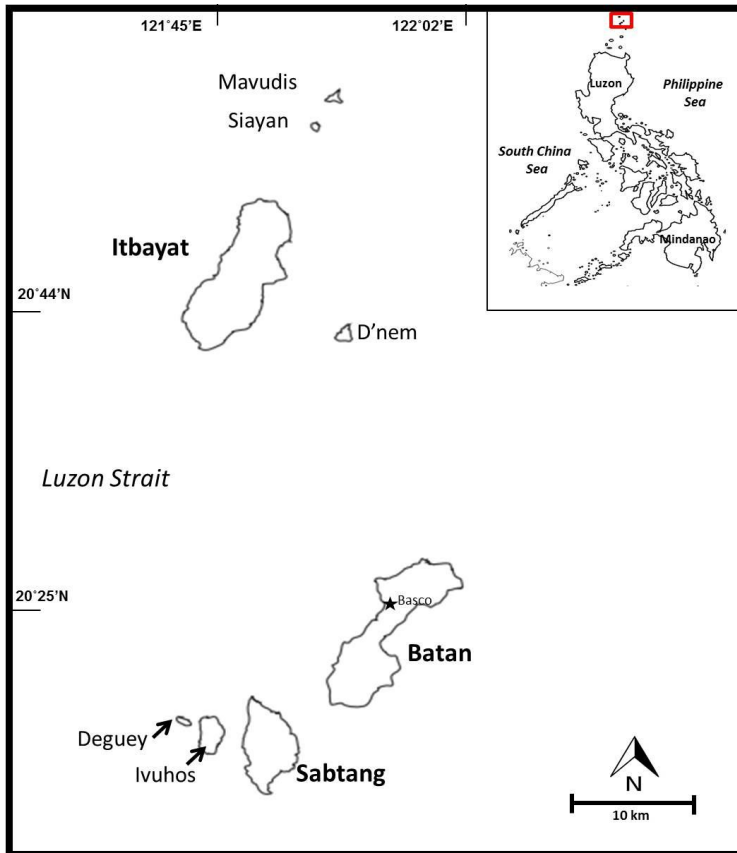


Figure 1. Map of Batanes Province, Philippines

Almost one-half of Batanes are hills and mountains. Batan Island, where the capital town (Basco) is found, is generally mountainous on the north and southeast. Itbayat Island slopes gradually to the west, while being mountainous and hilly along its northern and eastern coast. As for Sabtang, mountains cover the central part and the island slopes outward to the coast.

Batanes is classified as a very high priority conservation area for wildlife (Ong, et al., 2002). Its geographical isolation from the neighboring larger islands like Luzon and Taiwan accounts for the presence of endemics that thrive in its specific, specialized habitats (Diesmos et al., 2002). Alteration of these areas could threaten vulnerable endemics, most notably amphibians and reptiles, which are highly dependent on the integrity of their habitats. Documentation, update, and verification of herpetofaunal listing are therefore important for data analysis and development of appropriate conservation strategies in the province.

Pioneering herpetological studies in Batanes group of islands were conducted by Taylor (1922) and Brown and Alcala (1978, 1980). More recent biodiversity expeditions have been conducted in the Batanes island group following its proclamation as a Conservation Priority Area (CPA) in 2002 (Ong, et al., 2002). A few publications were produced from these efforts, such as: (1) current listing of herpetofaunal species observed in Batan Island (Oliveros, et al., 2011); (2) descriptions of a new geckonid *Lepidodactylus* on Batan Island (Ota and Crombie, 1989); and (3) taxonomic accounts on four *Lycodon* species in northern Philippines (Ota and Ross, 1994). This paper presents the results of a comparative survey of the amphibian and reptilian diversity (herpetofauna) in four major islands of Batanes, namely Batan, Ijuhohs, Sabtang, and Itbayat. The generated list of species would help in updating and verifying existing records on the herpetofauna of Batanes islands. Data from this study will be useful in adopting future conservation strategies for the islands composing Batanes Province, especially the inhabited islands prone to anthropologic disturbance.

MATERIALS AND METHODS

Surveys of herpetofauna were conducted in eight selected lowland sites with forest cover on four of the ten islands in Batanes, namely Itbayat, Batan, Sabtang and Ijuhohs (Table 1). These islands were chosen for their accessibility, land area, and presence of anthropologic disturbance. Three to five sampling days were completed in each study site from April to May 2006 and from May to June 2007. A total of nine hours per sampling day were spent in day and night searches for amphibians and reptiles. Three persons per sampling day were involved in the searches. Issues such as logistics, access and optimal weather and moisture conditions were considered in determining the sampling schedule.

Table 1. Localities visited from 2006 to 2007, listed by site number.

Study Site	Locality	Coordinates
1	Mt. Riposed, Barangay Raele, Itbayat Island	20° 44' 10" N, 121° 50' 15.7" E
2	Katunos watershed, Barangay Sta. Rosa, Itbayat Island	20° 48' 010" N, 121° 51' 00" E
3	Mt. Iraya, Barangay San Antonio, Batan Island	20° 26' 40.1" N, 121° 59' 51.7" E
4	Mt. Iraya, Barangay San Joaquin, Batan Island	20° 26' 69.3" N, 121° 59' 88.1" E
5	Mt. Matarem, Barangay Panatayan, Batan Island	20° 23' 57.9" N, 121° 56' 28.5" E
6	Barangay Malakdan, Sabtang Island	20° 20' 22.4" N, 121° 51' 58.7" E
7	Vichinyi, Barangay Sinakan, Sabtang Island	20° 20' 33" N, 121° 52' E
8	Ijuhohs Island	20° 18' 0.949" N, 121° 49' 0.027" E

Standard habitat description techniques using three kilometers line transects were established per site in a variety of habitats within a study site. Herpetofauna seen within five meters from both left and right sides of the transect line were recorded and counted. Representative species samples were

collected. Additional methods for survey include purposive microhabitat sampling in pools, seepage areas, burrows, decaying logs, forest litter, and undergrowth; ethnobiology; and photograph documentation of species. Specimens were identified to the species level whenever possible. Field identification guides and taxonomic papers by Alcalá (1986), Brown and Alcalá (1978, 1980), Ota and Crombie (1989), and Ota and Ross (1994) were used to identify species.

Specimens were caught by hand and/or by using snake hooks, and traps (e.g. pitfalls). Voucher specimens were fixed and preserved in 10% formalin before transport to the laboratory and deposited at the University of the Philippines at Los Baños Museum of Natural History (UPLB-MNH). Morphological and meristic characters of specimens were scored to key out to lowest possible taxonomic unit.

Species occurrence (presence/absence), relative species richness (number of species over total number of species), and percent endemism (number of endemics over total number of species) were determined and compared among the four islands. Sorensen's Index of Similarity was computed using the formula $S = 2C / A+B$, wherein C is the number of species common to both islands, and A and B are number of species in islands of interest. Data in this study were compared with existing herpetofaunal species records for Batanes.

RESULTS AND DISCUSSION

Overall species composition

A total of 19 herpetofaunal species representing two orders (Anura and Squamata), nine families (Rhacophoridae, Agamidae, Gekkonidae, Scincidae, Varanidae, Boidae, Colubridae, Elapidae [Hydrophiinae], and Viperidae), and 16 genera were recorded for Batanes Islands (Table 2). Specifically, ten lizards, eight snakes and only one amphibian were recorded, totaling to 95% reptiles (50% lizards and 44% snakes) and 5% amphibians. The most represented families are the Colubrids (five species), Gekkonids (four species) and Scincids (four species).

The Common Tree Frog (*Polypedates leucomystax*), whose occurrence has been attributed to anthropologic disturbance, was the only recorded amphibian. Five out of the eight recorded snake species were colubrids. Being a polyphyletic family, Colubridae usually has the highest diversity among the snake families. Four gekkonids, four scincids, one agamid and one varanid lizard compose the lizard assemblage recorded in this study. The total herpetofauna is composed of five Batanes endemic (26%) and ten Batanes-Babuyan endemics (53%) (Table 2).

Table 2. Taxonomic list of the herpetofauna recorded from the Batanes survey in 2006-2007.

ORDER	FAMILY	COMMON NAME	SPECIES
Anura (n=1)	Rhacophoridae	Common Tree Frog	Polypedates leucomystax
Squamata Suborder Lacertilia (n= 10)	Agamidae	Jareck's Flying Lizard	Draco jareckii*
	Gekkonidae	Batan Narrow-disked Gecko	Gekko porosus*
		Common House Gecko.	Hemidactylus frenatus
		Batan Scaly-toed Gecko	Lepidodactylus balioburius*
		Tender-skinned House Gecko	Gehyra mutilata
	Scincidae	Luzon Montane Skink	Eutropis bontocensis
		Cuming's Skink	Eutropis cumingi
		Eutropis sp. 1	Eutropis sp.
		Unidentified skink	Unidentified skink
	Varanidae	Marbled Water Monitor	Varanus marmoratus
Squamata Suborder Serpentes (n= 8)	Boidae	Reticulated Python	Malayopython reticulatus
	Colubridae	Alcala's Wolf Snake	Lycodon alcalai*
		Ota's Wolf Snake	Lycodon bibonius
		Red-tailed Green Ratsnake	Gonyosoma oxycephalum
		Luzon Slender Tree Snake	Dendrelaphis luzonensis
		Common Mock Viper	Psammodynastes pulverulentus
	Elapidae	Yellow-lipped Sea Krait	Laticauda colubrina
	Viperidae	McGregor's Pit Viper	Trimeresurus mcgregori*
Total number of species			19
Total number of Batanes endemics (%)			26%
Total number of species endemic to Batanes and Babuyan islands) (%)			53%

* - Batanes endemics

Species richness among islands

Table 3 shows that Batan and Sabtang have higher computed values for relative species richness (58%) compared to Itbayat (47%) (Table 3). This is in spite of the larger land area of Itbayat (92.9 km²) compared to Batan (78.70 km²) and Sabtang (40.70 km²). Ivuhos has the lowest value for species richness at 32%.

Molles (2006) stated that species richness in islands increases with area and decreases with isolation. The correlation between species richness and island size or area may be the result of increasing habitat heterogeneity in larger-sized island (Paulay, 1994). The more diverse the habitats, the more

available niches are there for different kinds of animals. On the other hand, because the probability of dispersal from a biodiversity source to an island is inversely related to distance (Paulay, 1994), the more isolated the island, the lesser is the chance for colonization.

It is suggested that the relative isolation of Itbayat may be a stronger factor than its size in explaining its low species richness. Compared to Batan and Sabtang, Itbayat is farthest from biodiversity sources such as Babuyan and Luzon Island. Its isolation might have prevented the colonization and radiation of species from the source islands, hence the occurrence of a lower number of species.

Although relatively solitary, species richness in Batan and Sabtang possibly resulted from colonization of species from diversity sources such as Luzon and Babuyan. The diversity of the more isolated islands like Itbayat may be attributed more to the radiation of a few original colonists compared to the dispersal of species from a diversity source (Paulay, 1994).

Ivuhos has only six out of the recorded 19 species (32%). Having the smallest land area, the island size may have been the limiting factor that explains the low herpetofaunal diversity and richness on Ivuhos Island.

Species diversity in Batan can be explained by its diverse and relatively continuous forest habitats and varied topography compared to Itbayat. As more frequent habitat fragmentation due to slash and burn farming was observed from the study sites in Itbayat, it is possible that the forest openings served as ecological barriers for species dispersal. The proportion of flat to steep terrain in Batan such as those observed from study sites 3, 4 and 5, provides possible geographic localization of species. In contrast, islands with low topographic variation such as the island of Itbayat, offer few geographic localities that can host various kinds of herpetofauna (Paulay, 1994).

Table 3. Herpetofauna in the four major islands of Batanes Province recorded from the 2006-2007 study.

	ISLAND			
	Itbayat	Batan	Sabatang	Ivuhos
AMPHIBIA				
Family Rhacophoridae				
Polypedates leucomystax	-	X	X	-
REPTILIA				
Family Agamidae				
Draco jareckii*	-	X	-	-
Family Gekkonidae				
Gekko porosus*	X	X	X	-
Hemidactylus frenatus	X	X	X	X
Lepidodactylus baliohurius*	X	X	X	X
Gehyra mutilata	-	-	X	-
Family Scincidae				

Comparison of Herpetofaunal Diversity among Four Major Islands of
Batanes Province, Northern Philippines

Eutropis cumingi	X	-	X	-
Eutropis bontocensis	X	-	X	X
Eutropis sp.	-	X	-	-
Unidentified skink	X	-	-	-
Family Varanidae				
Varanus marmoratus	-	X	-	-
Family Boidae				
Malayopython reticulatus	X	-	-	X
Family Colubridae				
Lycodon alcalai*	-	X	X	X
Lycodon bibonius	-	X	-	-
Gonyosoma oxycephalum	X	X	X	-
Dendrelaphis caudolineatus	X	-	-	-
Psammodynastes pulverulentus	-	-	X	-
Family Elapidae (Hydrophiidae)				
Laticauda colubrina	-	-	-	X
Family Viperidae				
Trimeresurus mcgregori*	-	X	X	-
TOTAL	9	11	11	6
Relative Species Richness	47%	58%	58%	32%
Percent Endemism*	11%	26%	21%	11%

X = distribution confirmed on the basis of specimen; * = Batanes endemic
Endemicity Among Islands

All five endemic species are present in Batan and Sabtang except for *D. jareckii* whose distribution in Sabtang is still unconfirmed. The relatively high number of Batanes endemics found in Batan and Sabtang can be attributed to a possible combination of dynamic intra-island and inter-island speciation between the two brought about by their habitat and topographic diversity.

Itbayat and Ivuhos each have two Batanes endemics: *L. balioburius* and *G. porosus* for Itbayat and *L. balioburius* and *L. alcalai* for Ivuhos. The low endemicity in Itbayat Island can be attributed to its almost uniform topography and less environmental variability. The uniform terrain and less diverse habitat types in study sites 1 and 2 may not allow for ecological isolation of populations within the island thus intra-specific speciation could be less. The distance of Itbayat from Batan and Sabtang does not support a possible inter-specific radiation.

Due to the small size of Ivuhos Island, there is less area for the occurrence of more variable habitats. The two Batanes endemics in the island could be attributed to recent colonization from the nearest island Sabtang. A clear evidence of this is the presence of the same Batanes endemics in Sabtang and Ivuhos namely *L. alcalai* and *L. balioburius*. As stated by Leviton (1963), colonization on a small island like Ivuhos might be brought about by “wind, rafting or human activities”.

Similarity of Species Among islands

Species similarity between Batan and Sabtang is high compared to each one’s similarity with the other islands ($S = 0.64$) (Table 4). The high similarity may be attributed to the close proximity between Batan and Sabtang which supports possible colonization of species between the two islands.

Table 4. Similarity of herpetofauna between islands. (Similarity of the Batanes endemic herpetofauna in parenthesis).

SIMILARITY COEFFICIENT (S)				
	Itbayat	Batan	Sabtang	Ivuhos
Itbayat		0.40 (0.57)	0.60 (0.66)	0.53 (0.50)
Batan			0.64 (0.89)	0.35 (0.57)
Sabtang				0.47 (0.67)

High similarity in the number of herpetofauna and Batanes endemics between Batan and Sabtang appears to provide convincing evidence that similar environmental characteristics may account for the presence of species in both islands. These characteristics include relatively large tracts of forest, diverse microhabitats, and varied topography in the two islands. The occurrence of forested areas in Batan and Sabtang can account for forest-dwelling endemics such as *L. alcalai*, *T. mcgregori*, *L. balioburius*, and *G. porosus*.

The low similarity coefficients between Batan-Itbayat and Batan-Ivuhos indicate the differences in complexity of topography, vegetation and microhabitats among the islands. The relatively high similarity between Sabtang and Ivuhos could be related to the occurrence of the same vegetation characteristics in forested areas found in the two islands.

Comparison of the Previous and Present Records of Batanes Herpetofauna

Fifteen herpetofaunal species in Batanes islands previously listed by Oliveros, et al. (2011), Ota and Ross (1994) and Taylor (1922) were confirmed in the present work. Consistent with the previous records, *Polypedates leucomystax* remains to be the only frog species from Batanes. Ota and Ross (1994) reported that it was presumably introduced in Batan Island. Snake and lizard species that are not island endemics have an established widespread distribution in the Philippines that is indicative of their adaptability to a wider range of habitat types.

Comparison of Herpetofaunal Diversity among Four Major Islands of
Batanes Province, Northern Philippines

The Brahminy blind snake, *Indotyphlops braminus*, was not observed during the 2006-2007 survey although it appears in all three previous listing. *Lycodon muelleri* and *Rhabdophis* (or *Amphiesma*) sp. listed by Taylor (1922) were also not observed.

The present study adds four new records to the species lists for Batanes Islands by Oliveros, et al. (2011) and Ota and Ross (1994). These species are *Eutropis cumingi*, *Lycodon bibonius*, *Dendrelaphis luzonensis* and *Laticauda colubrina* (Figure 2).



Figure 2. New records for Batanes islands, 2006-2007 survey: *Eutropis cumingi* (A), *Lycodon bibonius* (B), *Dendrelaphis luzonensis* (C) and *Laticauda colubrina* (D).

A total of three specimens of *Eutropis cumingi* were collected from Sites 2 and 7 (islands of Itbayat and Sabtang, respectively). Individuals were seen resting on trunks of low shrubs and trees growing along the stream, and on the ground, often camouflaged in leaf litter. One female specimen of *Lycodon bibonius* was collected from Site 4 (Mt. Iraya in Batan island). It was observed coiling around a slender branch of a low shrub. Two specimens of *Dendrelaphis luzonensis* were collected from Site 2 (Itbayat Island). Individuals were seen in trees growing along forest streams. Two specimens of Yellow-lipped Sea Krait, *Laticauda colubrina*, were collected in rocky shorelines of Ivuho Island.

These new records represent a 25% increase of herpetofaunal taxa recorded for Batanes and extend known distributions of these species.

CONCLUSION

New records on the herpetofauna of Batanes in the present study include one skink *Eutropis cumingi* and three snake species, *Lycodon bibonius*, *Dendrelaphis luzonensis* and *Laticauda colubrina*. All five Batanes reptilian endemics reported by previous studies namely, *Draco jareckii*, *Gekko porosus*, *Lepidodactylus balioburius*, *Trimeresurus mcgregori*, and *Lycodon alcalai* were confirmed present in Batanes Islands. Moreover, two skink species *Eutropis* sp. and one unidentified skink are awaiting identification. Studies within the islands might yield discovery of new species.

While Batanes has limited herpetofauna, the occurrence of endemic taxa makes it an important center for herpetological endemism. Further studies within the islands might yield new distributional records and discovery of new species. This justifies its importance as a priority area for research and conservation.

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STATEMENT OF AUTHORSHIP

This paper is part of the Master of Science thesis of the primary author. All authors conceptualized the framework of this paper and took part in the field expedition at Batanes Islands. The primary author wrote the final content, including the analysis and discussion of results, in consultation with the second and third authors.

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Comparison of Herpetofaunal Diversity among Four Major Islands of
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