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Original Article

Amphibians and reptiles from Leyte Sab-a Basin Peatland: A unique wetland habitat in Leyte, Philippines

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ABSTRACT

The Leyte Sab-a Basin Peatland (LSBP) is a unique wetland ecosystem that is an important refuge for biodiversity. However, the diversity of wildlife communities in peatland ecosystems, particularly herpetofauna (amphibians and reptiles), remains poorly understood. Therefore, the present study provides preliminary accounts of herpetofauna's occurrence, endemicity, habitat, and microhabitat use in LSBP. The field surveys in the peatland have yielded 39 herpetofauna species, comprising 13 frogs, 13 lizards, 12 snakes, and one turtle. Records from a previous study revealed a total of 44 herpetofauna species known to occur in peatland. A threatened species documented in the peatland is the Mindanao Fanged Frog (*Limnonectes magnus* Stejneger), which is already classified as near threatened based on the IUCN Red List of Threatened Species. The overall herpetofaunal endemicity was 64%, with an endemicity of 61% and 65% for amphibians and reptiles, respectively. The majority (69%) of the amphibian species occurred within the peatland area (peat swamp forests, grassland, and agricultural areas), while almost all (92%) of the reptile species were at least utilizing peatland edge/ecotone habitats. Around 43% of the amphibian species, mainly from the family Dicroglossidae, utilized terrestrial and aquatic microhabitats. For reptile species, a comparable portion of 46% utilized arboreal and terrestrial microhabitats.

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Lastly, it is crucial to implement conservation measures towards the unique ecology/biology of the herpetofauna species and the habitat dynamics in the peatland.

Keywords: Arboreal, endemic, Mindanao Pleistocene Aggregate Island Complex (PAIC)

INTRODUCTION

The Philippines, as an archipelagic country with 7,107 islands situated on the western edge of the Pacific Ocean and northeast of Sundaland in Southeast Asia (Diesmos 2008) is home to diverse species of amphibians and reptiles (Alcala et al 2004, Sanguila et al 2016, Gojo Cruz et al 2018, Meneses et al 2024). The evolution of the rich biodiversity, especially the herpetofauna of the country, is attributed to some crucial factors, such as the islands' complex geological history with long periods of isolation, a dynamic sequence of fragmentation and coalescence of landmasses during the Pleistocene (Heany 1985, Diesmos 2008, Brown et al 2013a, Khalighifar et al 2021). Previously thought of as having depauperate herpetofauna, the country has been recognized as one of the global centers of herpetological diversity and endemism (Diesmos et al 2002). Around 76% of known amphibians and reptiles in the Philippines are endemic (Diesmos et al 2015, Gojo Cruz et al 2018, Leviton et al 2018, Meneses et al 2024). However, the high diversity of amphibians and reptiles, along with many other species, are threatened mainly by anthropogenic activities (eg, deforestation and habitat loss), making the Philippines one of the twenty-five biodiversity hotspots in the world (Langenberger et al 2006, Gojo Cruz et al 2018).

In regards to biogeography, the herpetofauna of the Philippines exhibits a similar trend with terrestrial birds and non-volant mammals (Diesmos 2008). Specifically, Leyte Island belongs to a large biogeographic region called the Mindanao Pleistocene Aggregate Island Complex (PAIC) together with Samar, Biliran, Bohol, Mindanao, Dinagat, Siargao, and smaller associated islands (Beukema 2011). As part of the Mindanao PAIC, the island is home to many endemic amphibian and reptile species (Decena et al 2023). Even though previous expeditions have been conducted on Leyte Island, very few have focused on amphibians and reptiles (Mallari et al 2013), rendering the herpetofaunal diversity of the island to be poorly explored (Decena et al 2023). Very similar to the other parts of the country, prior investigations on Leyte Island's amphibians and reptiles were biased toward major ecosystems such as lowland and montane forests (Denzer et al 1994, Mallari et al 2013, Decena et al 2023), and virtually without considering other types of ecosystems (eg, wetland areas).

Tropical peatlands are unique wetland ecosystems occurring in tropical regions like Southeast Asia (Page et al 1999). These unusual ecosystems are characterized by extreme conditions of low pH, low nutrients, waterlogging, and peat accumulation (partially decomposed plant materials) that can be 20 m deep or more (Leo et al 2020). In the Philippines, there are only two confirmed tropical peatlands (peat swamp forests), with the largest, the Caimpugan peatland in Agusan Marsh on Mindanao Island (Aribal and Fernando 2018). The second is the Leyte Sab-a Basin Peatland (LSBP) located in the northeastern part of the Leyte Island (ASEAN Peatland Forest Project 2011). However, large portions of these peat swamp forests have already been cleared and drained for agricultural production (ASEAN Peatland

Forest Project 2011). As unique wetland habitats, the Caimpugan and LSBP have been found to harbor significant biodiversity in terms of avifauna (Matutes and Densing 2022), plants (Aribal and Fernando 2018), and herpetofauna (Densing and Matutes 2024).

Although wetlands like tropical peatlands could be an important refuge for amphibians and reptiles (Dertien et al 2020, Pupins et al 2023), studying these groups of fauna in the said ecosystem seems to be neglected or limited (Leo et al 2020). For example, in the Philippines, studies on the herpetofaunal communities in the peatland are extremely limited, with a single study on amphibian diversity in Agusan Marsh by Almeria and Nuñeza (2013) and a recent herpetofauna assessment in LSBP in Leyte (Densing and Matutes 2024). Therefore, the present study was conducted to augment the information about the herpetofauna communities in tropical peatlands of the country, in particular to LSBP. Specifically, it aims (a) to document the occurrence of amphibian and reptile species in the LSBP and secondly (b) to describe the endemicity, habitat, and microhabitat use of amphibians and reptiles.

MATERIALS AND METHODS

Study Area

The LSBP is a tropical peatland (peat swamp forests) situated in the northeastern portion of Leyte Island (Figure 1) with geographic coordinates of 11.21108° to 11.28048° N latitude and 124.89100° to 124.94814° E longitude. It is a characteristically elongated basin with a recently estimated area of 2,108.00ha (Decena et al 2021). The peatland holds the second most significant accumulation of peat soil, next to the Caimpugan Peatland of Agusan Marsh of Mindanao. It covers three municipalities, including Alangalang, Sta. Fe, and San Miguel.

Geomorphologically, the LSBP is bordered by ultramafic outcrops known as the Tacloban Ophiolite Complex (TOC) on the eastern flank. According to Suerte et al (2005), the peatland's underlying sediments comprise alluvial deposits derived from ultramafic rocks and sedimentary sequences. The water from the peatland mainly comes from surface run-off and streams and, at the same time, is drained by two river systems (Mainit River and Bangon River) (Asian Development Bank 2000).

In the 1970s, the Philippine government initiated a project to drain the peatland for agricultural development and land ownership provisions. The original peat swamp forest areas were cleared, and canals and artificial water outlets were constructed to allow agriculture (eg, rice production) (Asian Development Bank 2000). However, these areas were subsequently abandoned after a few years because of poor yields. This previous project left LSBP dominated by extensive sedges and grasses with significantly reduced forest cover (ASEAN Peatland Forests Projects 2018).

The study area has an equatorial rainforest-fully humid climate (Kottek et al 2006), characterized by the absence of a dry season and more or less evenly distributed rainfall throughout the year. The average temperature is 28.10°C, with April being the warmest month. The pronounced wetness occurs in the months of November, December, and January, with rainfall of 279.00mm, 305.30mm, and 281.17mm, respectively (Quiñones and Asio 2015).

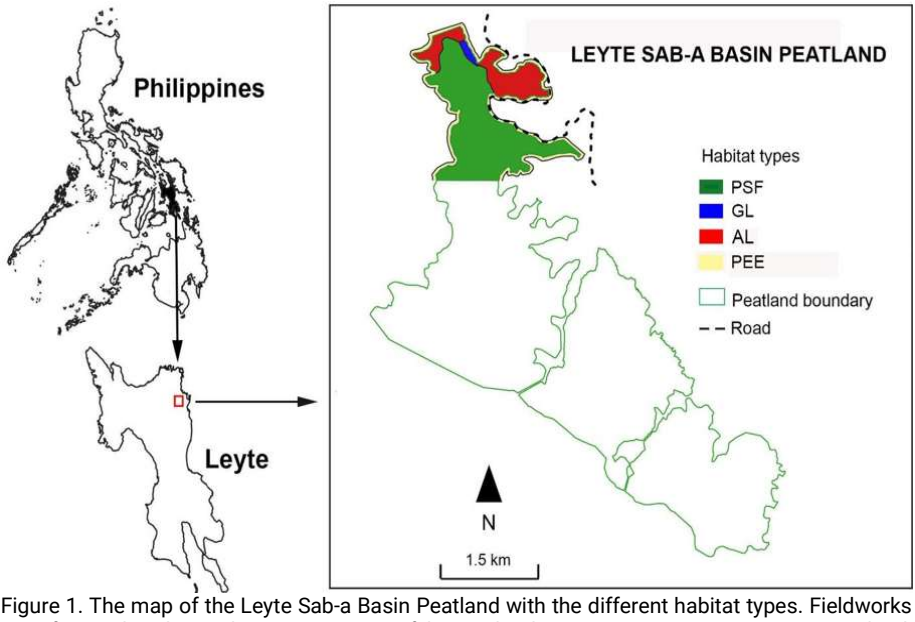

Figure 1. The map of the Leyte Sab-a Basin Peatland with the different habitat types. Fieldworks were focused on the northernmost portion of the peatland. PSF=Peat Swamp Forst, GL=Grassland, AL=Agricultural, PEE=Peatland Edge/Ecotone

Habitat

Peat swamp forests

The peat swamp forests (11.27152°N latitude, 124.90230°E longitude) (Figure 2A) in the LSBP sampled comprise the remnant original forests located in the northernmost portion of the peatland. These forests are dominated by tree species such as Marsh Holly (*Ilex cymosa* Blume) and Lanipau (*Termenalia copelandii* Elmer) and are often covered with thick vines and epiphytic plants. Meanwhile, the understorey vegetation is primarily composed of sedges like Sumatran Sawsedge (*Mapania sumatrana* [Miq.] Benth.) and Nutrush (*Scleria scrobiculata* Nees and Meyen) (Decena et al 2021). In addition, peat swamp forests are subjected to minor disturbance, including occasional harvesting of wood for construction and trails created from fishing activities.

Grasslands

Grassland and sedge areas (11.27841°N latitude, 124.90180°E longitude) (Figure 2B) cover the larger portions of LSBP, which are abandoned croplands. The dominant vegetation in these habitats includes Nutrush and Globular Fimbristylis (*Fimbristylis globulosa* [Retz.] Kunth), with occasional trees of the species Leichhardt Tree (*Nauclea orientalis* [L.] L.). These areas were originally peat swamp forests but have been cleared and drained for agricultural production. Current disturbances in the grassland areas include fires during the drier months, as well as grazing by water buffalo.

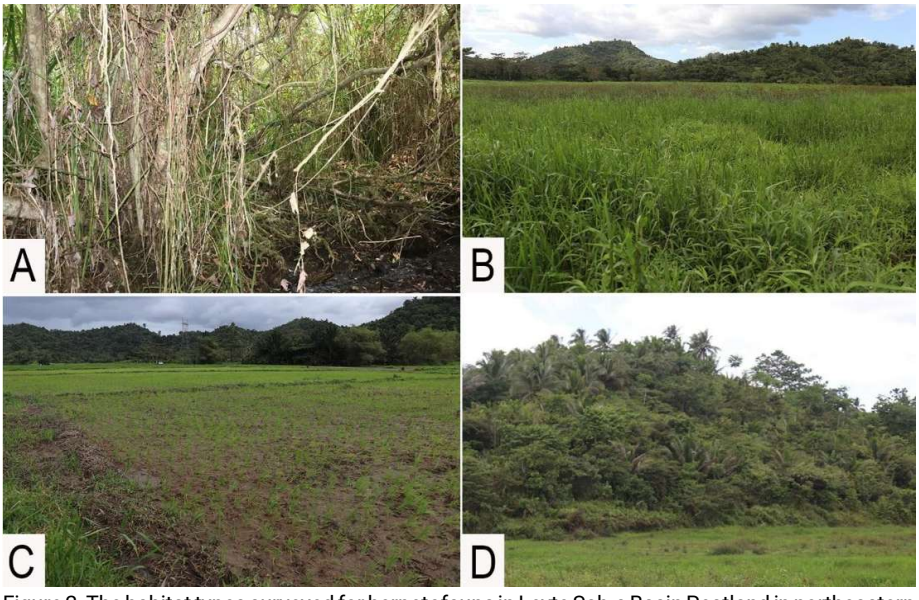

Figure 2. The habitat types surveyed for herpetofauna in Leyte Sab-a Basin Peatland in northeastern Leyte, Philippines. (A) Peat Swamp Forest; (B) Grassland; (C) Agricultural; and (D) Peatland Edge/Ecotone.

Agricultural

Agricultural areas (11.27487°N latitude, 124.90755°E longitude, and 11.28090°N latitude, 124.89801°E longitude) (Figure 2C) of the peatland are commonly found in the peripheries, which are easily accessed by the local communities. Cultivation in the peatland is mainly subsistence consisting of rice and other crops such as taro, giant taro, and sago palm. The areas for rice production are at least cultivated once a year with the aid of farm machinery. They are fertilized with nitrogen, phosphorus, and potassium, usually as urea or complete fertilizer. In addition, canals are commonly observed for drainage purposes, resulting in lower water content of the peatland. Though this habitat is the result of land use conversion, agricultural areas and grassland areas remain classified as peatland as they still contain a significant accumulation of peat soil (Decena et al 2021).

Peatland edge/ecotone

The edge of the peatland (11.27881°N latitude, 124.90476°E longitude, and 11.27098°N latitude, 124.90511°E longitude) (Figure 2D) sampled was mainly characterized by an agroecosystem since the majority of the natural forests surrounding the peatland had long been removed and replaced primarily to coconut plantations and many other crops. These coconut plantations are characterized by the presence of many early successional tree species mixed with non-native trees like Gmelina (*Gmelina arborea* Roxb.) and Big-leaf Mahogany (*Swietenia macrophylla* King). At the same time, communities (barangays) are located nearby and are likely directly involved in resource extraction and disturbance in the peatland.

Although disturbed habitats already dominate the peatland's edge, the areas are still characterized by secondary forests. These forests are usually located in the northern part of the peatland and adjacent to the surrounding hills.

Herpetofaunal Sampling

For herpetofauna sampling, broad habitat types considered were peat swamp forests, grassland, agricultural, and ecotone/edges. The fieldworks were focused on the northern portion of the peatland as it is the location of the last remaining intact and less disturbed peat swamp forests and other habitat types. The herpetofaunal survey was based on several visits from February to April 2024 (February 2, 9, 11, 17, 23, and 28-29; March 1, 15, and 23; April 4 and 19). The sampling employed an active search method (Heyer et al 1994) whereby all possible substrates (soil, litter, log, branches, leaves) were thoroughly searched for amphibians and reptiles. Sampling was done twice on the same day, first in the afternoon from 2:00PM to 5:00PM and then at night from 7:00PM to 10:00PM. These were done to sample both diurnal and nocturnal species. There were no morning surveys at all due to logistical issues. Two or three people (with the head torch for night sampling) slowly walked and thoroughly searched and recorded herpetofauna species that were encountered and captured. The active search method was conducted in peat swamp forest, grassland, agricultural, and peatland edges/ecotones of the LSBP within an area of approximately 181, 4, 58, and 4ha, respectively. Not all the areas of each habitat type were sampled, especially the peat swamp forests, due to extensive coverage and issues with accessibility. All the habitat types were visited for active search sampling on each day of the sampling campaign. The sampling effort in this study was approximately 216 man-hours (3 people × 12 days × 6h). Moreover, the adequacy of the sampling effort for the active search method was assessed by generating a species accumulation curve using the *iNEXT* package in *R* (Hsieh et al 2016).

In addition, to sample fossorial species inhabiting the drier part of the peatland and in the ecotone, pitfall traps were set up consisting of 3 plastic buckets embedded in the ground and 5m apart (modified from Gillespie et al 2015). Each bucket was connected with a blue sack 50cm high and 20m long, passing across each bucket, with the bottom edge embedded in the ground. The traps were checked daily for at least two weeks. Only one pitfall trap was established in the peat swamp forest and the ecotone area. No pitfall traps were set up in the agricultural and grassland because these land uses were actively cultivated or used for grazing.

Amphibians and reptiles microhabitats were determined by recording their location when they were first observed (Plaza and Sanguila 2015). Microhabitats were classified into three categories: arboreal, terrestrial, and aquatic. Arboreal microhabitats included tree trunks, canopy, shrubs, vines, and epiphytes. Terrestrial microhabitats included soil, litter, and fallen logs. Lastly, aquatic microhabitats were characterized by canals, temporary pools, paddles of water, and springs.

Representative herpetofauna individuals were photographed for photo-vouchering purposes and recorded locations using a handheld GPS. All the captured individuals were released unharmed at the location of the observation. Species identifications followed the nomenclature of Sanguila et al (2016), Diesmos et al (2015), Brown et al (2013), and Weinell et al (2019). We also consulted databases such as AmphibiaWeb (2024) and The Reptile Database (Uetz et al 2024).

RESULTS

This recent survey documented 39 herpetofauna species belonging to 17 families in various habitats in the LSBP in Northeastern Leyte (Tables 1 and 2). The herpetofauna encountered comprised 13 frogs, 13 lizards, 12 snakes, and one turtle species. Based on The IUCN Red List of Threatened Species (IUCN 2023), the amphibian Mindanao Fanged Frog (*Limnonectes magnus* Stejneger) was already classified as near threatened, and all the rest of the species were classified as least concern (Table 1 and 2). The species accumulation curve for reptiles indicates that most of the species that likely occurred in the sampled habitat types were detected (Figure 3). On the other hand, the species accumulation curve (interpolated and extrapolated) for amphibians was still farther from the asymptote, suggesting much more additional sampling efforts are needed to document unseen species (Figure 3).

Table 1. List of amphibians recorded in the different habitats in Leyte Sab-a Basin Peatland in northeastern Leyte, Philippines. Habitat, PSF-peat swamp forest, GL-grassland, AL-agricultural, PE-peatland edge/ecotone; Microhabitat, Ar-arboreal, Te-terrestrial, Aq-aquatic; Threat status according to The IUCN Red List of Threatened Species (IUCN, 2024), LC-least concern, NT-near threatened.

Species	Habitat	Micro-habitat	IUCN Status	Coordinates	
				Latitude	Longitude
Amphibia					
Bufonidae					
Rhinella marina	AL	Te	LC	11.276260	124.902828
Ceratobatrachidae					
Platymantis guentheri	PSF, GL	Ar	LC	11.273472	124.902889
Dicroglossidae					
Fejervarya vittigera	GL, AL	Te,Aq	LC	11.275552	124.905048
Limnonectes leytensis	PSF	Te, Aq	LC	11.277361	124.908250
Limnonectes magnus	PE	Te,Aq	NT	11.277667	124.909056
Occidozyga laevis	PSF	Aq	LC	11.278537	124.899084
Megophryidae					
Megophrys stejnegeri	PE	Te	LC	11.274212	124.914614
Microhylidae					
Kalophrynus sinensis	PE	Te	LC	11.278806	124.905528
Kaloula picta	PE	Te	LC	11.276877	124.909336
Oreophryne anulata	PSF	Ar	LC	11.273639	124.902889
Ranidae					
Hylarana erythraea	GL, AL	Aq, Ar	LC	11.273472	124.902889
Rhacophoridae					
Philautus leitensis	PSF	Ar	LC	11.278806	124.900139
Polypedates leucomystax	PSF, PE	Ar, Aq	LC	11.278472	124.898285

Table 2. List of reptiles recorded in the different habitats in Leyte Sab-a Basin Peatland in northeastern Leyte, Philippines. Habitat, PSF-peat swamp forest, GL-grassland, AL-agricultural, PE-peatland edge/ecotone; Microhabitat, Ar-arboreal, Te-terrestrial, Aq-aquatic; Threat status according to The IUCN Red List of Threatened Species (IUCN, 2021), LC-least concern.

Species	Habitat	Micro-habitat	IUCN Status	Coordinates	
				Coordinates	Coordinates
LIZARDS					
Agamidae					
Bronchocela sp.	PSF, PE	Ar	LC	11.275944	124.903444
Draco ornatus	PE	Ar	LC	11.279028	124.904972
Hydrosaurus pustulatus	PSF, AL, PE	Ar	LC	11.276278	124.903333
Gekkonidae					
Gekko gecko	PSF, PE	Ar	LC	11.277167	124.908694
Hemidactylus frenatus	PE	Ar	LC	11.277326	124.908636
Scincidae					
Brachymeles orientalis	PSF	Te	LC	11.277556	124.906806
Eutropis multicarinata	PE	Te	LC	11.269583	124.905778
Eutropis multifasciata	PSF, GL, AL, PE	Te	LC	11.276104	124.902735
Lamprolepis smaragdina philippinica	PSF, PE	Ar	LC	11.278577	124.898959
Lipinia pulchella pulchella	PE	Ar	LC	11.271667	124.898889
Pinoyscincus jagori jagori	PE	Te	LC	11.271667	124.898889
Tropidophorus grayi	PE	Te	LC	11.277361	124.908250
Varanidae					
Varanus samarensis	PSF, PE	Te	LC	11.277420	124.908565
SNAKES					
Colubridae					
Boiga cynodon	PE	Ar	LC	11.271389	124.905139
Boiga dendrophila latifasciata	PE	Te	LC	11.272139	124.905667
Calamaria lumbricoidea	PE	Te	LC	11.238444	124.931583
Coelognathus erythrurus erythrurus	PE	Te	LC	11.242861	124.928361
Dendrelaphis marenae	PE	Ar	LC	11.277611	124.904278
Lycodon dumerilii	PE	Te	LC	11.267028	124.919500
Stegonotus muelleri	PE	Te, Aq	LC	11.277306	124.904222
Elapidae					
Naja samarensis	PE	Te	LC	11.217917	124.946528
Lamprophiidae					
Oxyrhabdium modestum	PE	Te	LC	11.232417	124.936361
Psammodynastes pulverulentus	PSF, GL	Ar	LC	11.278485	124.899005
Typhlopidae					
Ramphotyphlops sp.	PSF, PE	Ar	-	11.269278	124.906528
Viperidae					
Tropidolaemus philippensis	PE	Ar	LC	11.266790	124.912060
TURTLES					
Bataguridae					
Cuora philippinensis	AL, PE	Aq	-	11.279222	124.905000

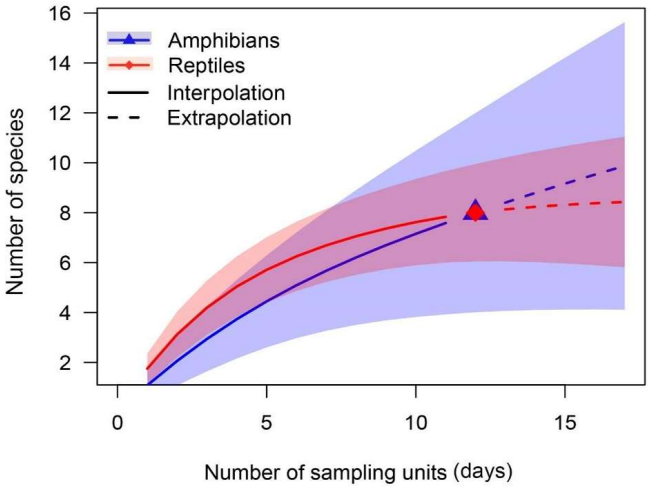

Figure 3. The species accumulation curve for amphibians and reptiles shows interpolated species richness up to the actual sampling units used and extrapolated species richness given additional sampling units.

Species Accounts: Amphibia Bufonidae

Cane Toad (Rhinella marina [Linnaeus])

Only a single individual of Cane Toad (Figure 4A) was encountered in the LSBP, particularly in the sago palm areas. This bufonid species utilizes the terrestrial microhabitat characterized by degraded and drained peat. In the study of Almeria and Nuñeza (2013), the species was found to be abundant in peat swamp forests of Agusan Marsh in Mindanao, Philippines. Moreover, previous herpetofauna studies or surveys on the island have shown that Cane Toad occupied a wider range of disturbed habitats, such as pastures, grasslands, coconut plantations, and even secondary forests (Decena et al 2020, Decena et al 2023). The species is non-native to the Philippines and was originally introduced to the country during the Industrial Revolution to control pests in sugar cane fields (Diesmos et al 2006). This non-native and invasive species is widely distributed in the Philippine archipelago (Diesmos et al 2015).

Ceratobatrachidae

Guenther's Forest Frog (Platymantis guentheri [Boulenger])

Guenther's Forest Frog (Figure 4B) was one of the most abundant amphibians, inhabiting both the peat swamp forests and grassland areas of LSBP. This frog was found to be strictly arboreal, where calling male individuals was frequently observed in understory sedges. This species was found to be common in the montane forests of Mt. Aminduen on the eastern part of Leyte Cordillera at an elevation of 1100masl (Decena et al 2023). In addition, the species can also persist and be found to be abundant in disturbed habitats

such as second growth, degraded, and fragmented habitat patches as long as there is sufficient precipitation (Sanguila et al 2016). This arboreal frog species is known to inhabit non-riparian environments and breeds by direct development as one of its life history adaptation strategies (AmphibiaWeb 2024). Guenther's Forest Frog is endemic to the Mindanao PAIC and found on the islands of Biliran, Bohol, Dinagat, Leyte, Mindanao, and Samar (Diesmos et al 2015).

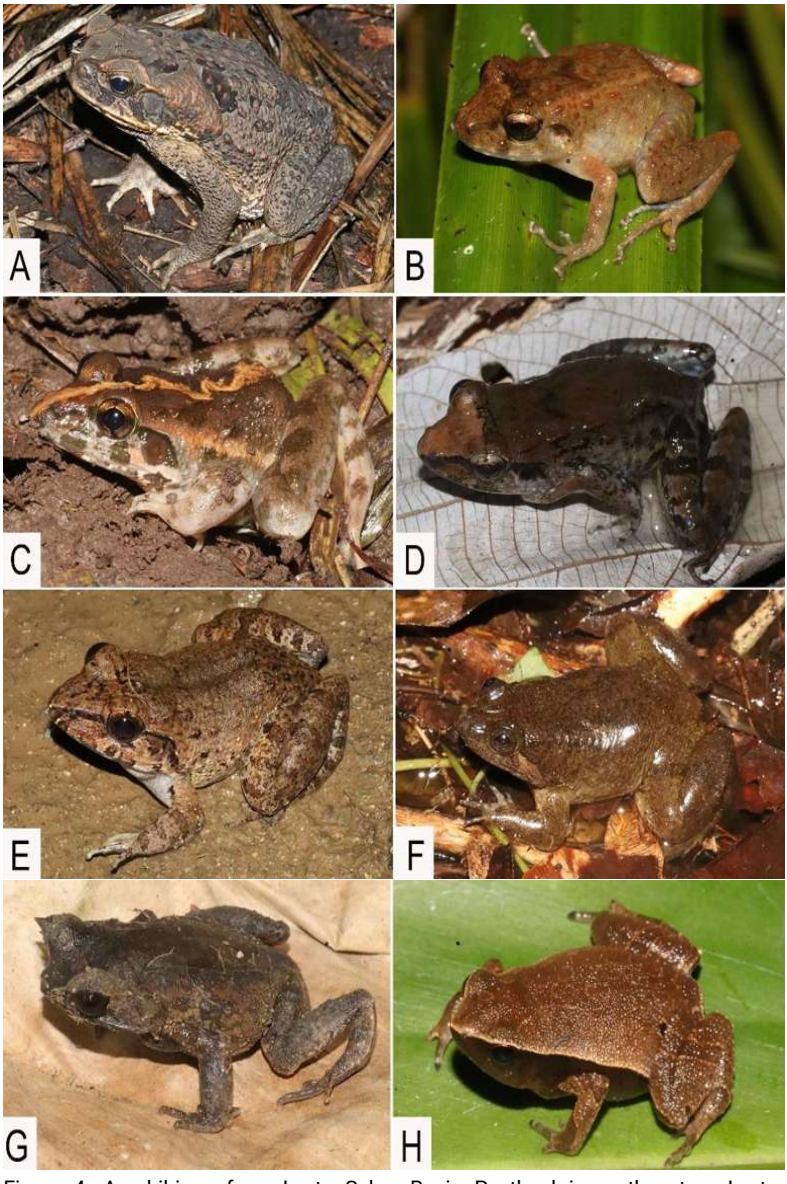

Figure 4. Amphibians from Leyte Sab-a Basin Peatland in northeastern Leyte, Philippines. (A) *Rhinella marina*; (B) *Platymantis guentheri*; (C) *Fejervarya vittigera*; (D) *Limnonectes leytensis*; (E) *Limnonectes magnus*; (F) *Occidozyga laevis*; (G) *Megophrys stejnegeri*; and (H) *Kalophrynus sinensis*.

Dicroglossidae

Luzon Wart Frog (Fejervarya vittigera [Weigmann])

Similarly, the Luzon Wart Frog (Figure 4C), which utilizes both terrestrial and aquatic microhabitats in the grassland and agricultural areas, was commonly encountered in the peatland. The species is considered as low elevation resident that prefers to inhabit highly disturbed areas with standing water (rice fields, ponds, and lakes) or along small, denuded streams bordering agricultural areas (Brown et al 2013b). Individuals of these species can be readily recognized by their loud "honking" advertisement call and aggregation in large choruses, especially after heavy downpours of rain (Sanguila et al 2016, Venturina et al 2020). However, this species has a declining population (IUCN 2023), which can be attributed to various threats such as hunting for meat and displacement by invasive species (Diesmos et al 2006, Venturina et al 2020). Historically, Luzon Wart Frog is the first endemic Philippine species known to science (Sanguila et al 2016) that is widely distributed in the country (Diesmos et al 2015).

Small Disked Frog (Limnonectes leytensis [Boetgerl])

Small Disked Frog (Figure 4D) appeared to be the most abundant frog species in the peat swamp forests of LSBP. Likewise, the previous study of Almeria and Nuñeza (2013) has shown Small Disked Frog to be the second most abundant amphibian species in the Agusan Marsh of Mindanao Philippines, inhabiting various habitats such as peat swamp forests, mixed swamp forests, *Terminalia* forests, and sago swamp forests. In addition, the species inhabits also streams and rivers in low-elevation forests and forest edges (IUCN 2023). In the study area, this frog species utilizes aquatic and terrestrial microhabitats. Individuals were often observed in small pools of water, understorey vegetation (close to the ground), and drained or degraded peat. The calls of male individuals were often heard especially after or during rainy times. It is readily identified by its small body size, rugose skin, and "v" mark on the scapular region (Siler et al 2009). Small Disked Frog is endemic and widely distributed in the Mindanao, Visayan, and Romblon PAICs (Sanguila et al 2016).

Mindanao Fanged Frog (Limnonectes magnus [Stejneger])

Individuals of Mindanao Fanged Frog (Figure 4E) were only encountered at the edges of the LSBP rather than in the swampy areas. The peatland edge or ecotone where the species was observed was characterized by the presence of coconut plantations, secondary forests, and even settlements. This large-bodied frog also thrives in forest habitats (primary or selectively logged forest), and even in much-disturbed habitats such as agroecosystems and pasture areas (Decena et al 2023). Specifically, individuals of Mindanao Fanged Frog were observed to use terrestrial (eg, moist ground and grassy areas) and aquatic microhabitats (eg, temporary pools and springs). Informal interviews with the locals in the study area reveal that the species is also hunted for its

meat, as also reported by other researchers (Sanguila et al 2016, Venturina et al 2020). Currently, the species is classified as Near Threatened based on The IUCN Red List of Threatened Species (IUCN 2023). Moreover, the distribution of Mindanao Fanged Frog is restricted to the Mindanao PAIC that is found on the islands of Basilan, Biliran, Bohol, Camiguin Sur, Dinagat, Leyte, Mindanao, and Samar (Diesmos et al 2015, Sanguila et al 2016).

Common Puddle Frog (Occidozyga laevis[Günther])

Common Puddle Frog (Figure 4F) was fairly common and was only encountered in the peat swamp forests. This common frog species also prefers other habitats, such as small streams in forested areas, flooded rice fields, and high-elevation cascading streams (Sanguila et al 2016, Decena et al 2023). As a peat swamp forest dweller, it utilizes an aquatic microhabitat where individuals are usually observed immersed or sitting in small pools. Common Puddle Frog is widely distributed in the Philippines but is a non-endemic one (Diesmos et al 2015).

Megophryidae

Mindanao Horned Frog (Megophyrs stejnegeri [Stejneger])

Only a single individual of Mindanao Horned Frog (Figure 4G) was encountered inhabiting the peatland edge characterized by coconut and banana plantations. This species is also a known resident of lowland forests (interior and streams) and montane forests (Baron et al 2021, Decena et al 2023). Microhabitats of Mindanao Horned Frog may include leaf litter, forest floor, tree roots, and standing water pools (Plaza and Sanguila 2015). It can be readily identified morphologically by the presence of a pair of prominent glands of the axial region on its ventral side and the presence of dermal projections on top of its eyelids (Sanguila et al 2016). Lastly, it is endemic to the Mindanao PAIC and distributed on the islands of Bohol, Dinagat, Leyte, Mindanao, and Samar (Diesmos et al 2015).

Microhylidae

Black-spotted Sticky Frog (Kalophrynus sinensis Peters)

Only a single juvenile individual, Black-spotted Sticky Frog (Figure 4H), was documented on the edge of the peatland. The species utilizes terrestrial microhabitats in coconut plantations where it was observed among the ground leaf litters. Other observations also show that it utilizes aquatic microhabitats such as temporary pools and water-filled cavities in various habitats (Plaza and Sanguila 2015, Sanguila et al 2016). The species has been recently observed to puff up its body and produce sticky mucus as a defensive mechanism against predators (eg, snakes) (Cuta et al 2022). This non-endemic species is found among the islands of the Philippines, such as Basilan, Bohol, Camiguin Sur, Culion, Dinagat, Leyte, Mindanao, and Samar (Diesmos et al 2015).

Painted Narrowmouth Toad (Kaloula picta [Duméril and Bibron])

Two individuals of Painted Narrowmouth Toad (Figure 5A) were documented, utilizing terrestrial microhabitats on the edge of the peatland. Individuals were encountered among the human settlements suggesting their tolerance to severely modified habitats. This species can be observed in dense aggregations in flooded rice fields and temporary ponds in the rainy season (Sanguila et al 2016). The Painted Narrowmouth Toad is endemic to and is widely distributed in the Philippines (Brown et al 2013b, Diesmos et al 2015).

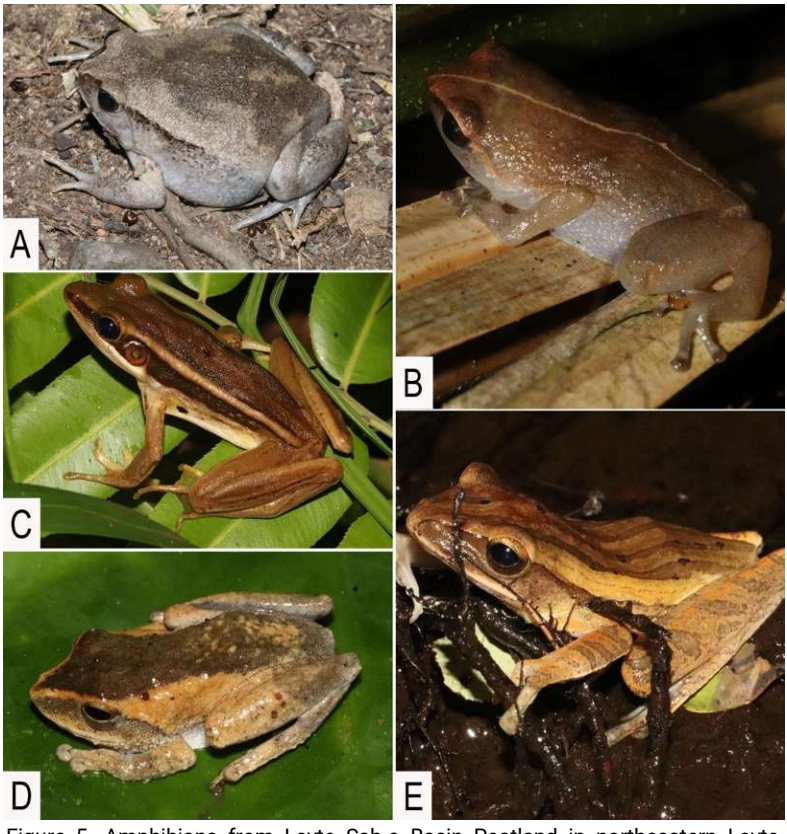

Figure 5. Amphibians from Leyte Sab-a Basin Peatland in northeastern Leyte, Philippines. (A) *Kaloula picta*; (B) *Oreophryne anulata*; (C) *Hylarana erythraea*; (D) *Philautus leitensis*; and (E) *Polypedates leucomystax*.

Mindanao Cross Frog (Oreophryne anulata [Stejneger])

Only a single individual of Mindanao Cross Frog (Figure 5B) was encountered in the LSBP, which could suggest its very low abundance or low detectability coupled with minimal survey effort in the area. These could be the reasons why previous herpetological surveys on Leyte Island failed to document this species (Denzer et al

1994, Mallari et al 2013, Decena et al 2020, Decena et al 2023). The lone individual utilized an arboreal microhabitat that was seen partially hidden among the leaves of sedges 0.5m from the ground in a peat swamp forest. The frog species has been originally observed in high-elevation forest habitats (Pitogo et al 2021), and its observation in peat swamp forest areas could reflect its other habitat. As previously reported, this species differed from Camiguin Narrow-mouthed Frog (*Oreophryne nana* Brown and Alcala) by having subarticular tubercles on the hand (Brown and Alcala 1967). This Mindanao PAIC endemic species is only found on the islands of Leyte, Mindanao, and Samar (Diesmos et al 2015).

Ranidae

Common Green Frog (Hylarana erythraea [Schlegel])

Common Green Frog (Figure 5C) is an introduced species (Diesmos et al 2006) that is found to be common in the grassland and cultivation areas in the LSBP. Similarly, Leo et al (2020) found the species to inhabit the peat swamp forest in Zamrud National Park in Indonesia within its native range. As a disturbance-tolerant species, it can also be found in other habitats, such as man-made ponds and lakes, residential areas, and edges of secondary forests (Siler et al 2012, Devan-Song and Brown 2012, Supsup et al 2016). In the peatland, it exploits both aquatic and arboreal microhabitats, but it was more often encountered perching in vegetation around a meter from the ground. Common Green Frog is found on many major islands of the Philippines except in Palawan and Mindanao (Diesmos et al 2015).

Rhacophoridae

Leyte Tree Frog (Philautus leitensis [Boulenger])

The Leyte Tree Frog (Figure 5D) was exclusively encountered in the peat swamp forest and is a fairly common arboreal species next to Guenther's Forest Frog. At the same time, this species is a common resident in lowland forests and montane forests (Pitogo et al 2021, Decena et al 2023). As a forest specialist, the species is found in arboreal microhabitats such as leaf or leaf axil, petiole, dead branches, and even ground between fern fronds and moss (Baron et al 2021). Likewise, in the peatland, individuals of this species were often observed perching in the sedges. Its characteristics, which include the presence of very minimal tubercles or asperities on its back and the absence of vomerine teeth, distinguish it from the rest of the genus *Philautus* in Mindanao (Brown and Alcala 1994). The Leyte Tree Frog is endemic to the Mindanao PAIC and is specifically found on the islands of Bohol, Leyte, Mindanao, and Samar (Diesmos et al 2015).

Common Tree Frog (Polypedates leucomystax [Gravenhorst])

Common Tree Frog (Figure 5E) were encountered in the LSBP, particularly in peat swamp forests and more frequently in the edges of the peatland. Moreover, the species is known to inhabit various habitats, including forests and streams, and even in highly altered ones such as agricultural areas and settlements (Devan-Song and Brown 2012, Supsup et al 2016). In the peripheries of the peatland, species

mainly used arboreal microhabitats where individuals were commonly observed perching in branches of small trees and leaves. This native but non-endemic species is widely distributed in the Philippine archipelago (Diesmos et al 2015).

Species Accounts: Reptilia (Lizards)

Agamidae

Bronchocela sp.

Bronchocela sp. (Figure 6A) was found to be common in the LSBP, particularly at the edge of the peatland (eg, coconut plantations, bushes, and secondary forests). However, there was a single encounter in the peat swamp forests. The encounters of the agamid species were during the night when individuals were observed asleep on small branches of trees, shrubs, and palm fronds around 1 to 4 m from the ground. Historically, taxonomic issues have existed in the genus *Bronchocela*, specifically between the Marbled Crested Lizard (*Bronchocela marmorata* Gray) and the previously regarded widespread (Philippines and Southeast Asia) Green Crested Lizard (*Bronchocela cristatella* [Kuhl]) (Supsup et al 2017, McLeod et al 2011).

White-spotted Flying Lizard (Draco ornatus [Gray])

The White-spotted Flying Lizard (Figure 6B) was found to exclusively inhabit the edge of the peatland, particularly in the coconut plantations. Similarly, the previous study by Decena et al (2023) found the species among the latter habitats; however, in contrast, Sanguila et al (2016) characterized it as a primary and secondary forest inhabitant. At the study site, individuals of the species are active during the day, utilizing arboreal microhabitats, and tend to glide between adjacent coconut palms when disturbed. Informal interviews with the local guides revealed that the locals are hunting these agamids for their belief in the species' medicinal values. The White-spotted Flying Lizard is a Mindanao PAIC endemic restricted to the islands of Bohol, Dinagat, Leyte, Mindanao, and Samar (IUCN 2023).

Philippine Sailfin Lizard (Hydrosaurus pustulatus Eschsholtz)

The Philippine Sailfin Lizard (Figure 6C) was observed to utilize multiple habitats in the LSBP, including peat swamp forests, agricultural, and edges/ecotone areas. Other preferred habitats of this agamid lizard include riparian areas and corridors, coastal forests, mangrove forests, agroecosystems, and pastures (Sanguila et al 2016, Meneses et al 2022, Decena et al 2023). This large and semi-aquatic agamid was observed to utilize arboreal microhabitats where individuals were observed asleep on tree branches or shrubs over ditches and canals. In forest habitats, individuals are also usually observed asleep on branches over streams (Siler et al 2011, Siler et al 2012). This species is threatened not only by the degradation of the peat swamp forest but also hunting by locals for its meat. The Philippine Sailfin Lizard is endemic to the Philippines and occurs on all major and many small isolated islands, except for Palawan (Siler et al 2012).

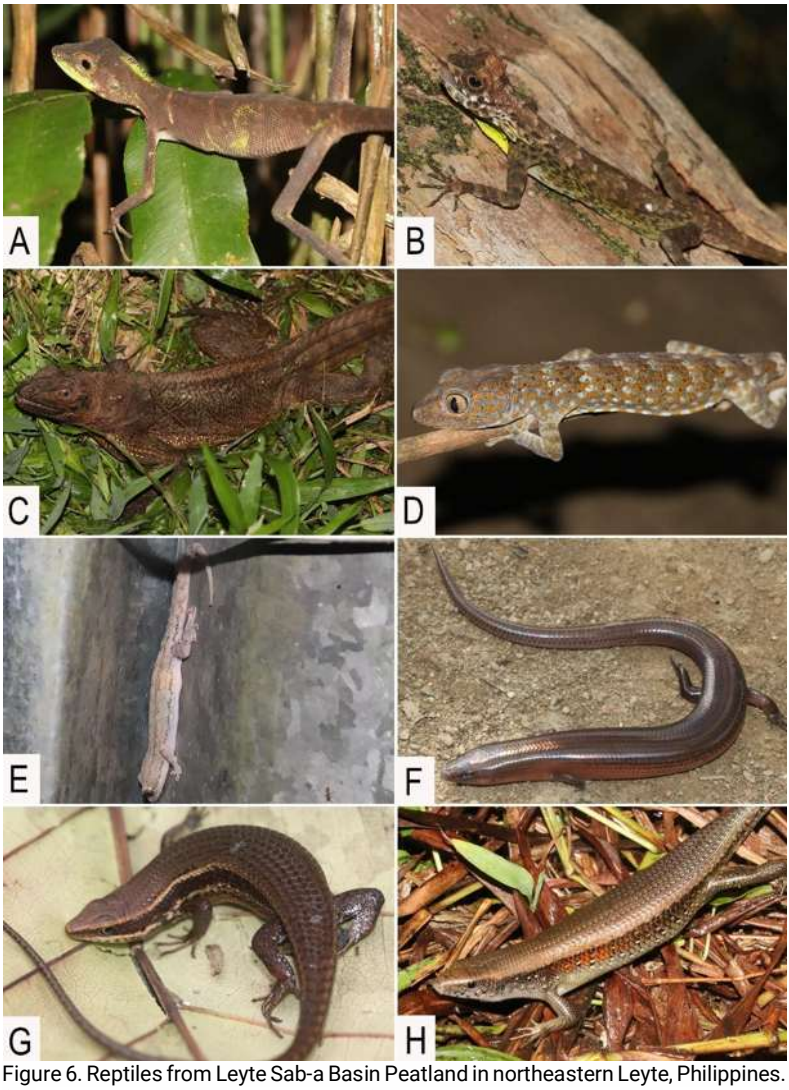

Figure 6. Reptiles from Leyte Sab-a Basin Peatland in northeastern Leyte, Philippines. (A) *Bronchocela* sp.; (B) *Draco ornatus*; (C) *Hydrosaurus pustulatus*; (D) *Gekko gecko*; (E) *Hemidactylus frenatus*; (F) *Brachymeles orientalis*; (G) *Eutropis multicarinata*; and (H) *Eutropis multifasciata*.

Tokay Gecko (Gekko gecko [Linnaeus])

Tokay Gecko (Figure 6D) was observed to be common in the LSBP area and utilized arboreal microhabitats such as trees, palms, and even man-made structures. The majority of the encounters were on the edges of the peatlands, especially in coconut plantations and settlements, likewise in the peat swamp forests areas, often heard calling among Lanipau trees. The occurrence of these species in many habitat types with various disturbance levels indicates their higher tolerance. Tokay Gecko is widespread in Southeast Asia, including in the

Philippines, where it is known to occur in all the islands, except in Batanes, Babuyanes, and Polillo (Brown and Alcala 1978).

Common House Gecko (Hemidactylus frenatus [Duméril & Bibron])

This human commensal species was frequently encountered in the settlement areas at the peatland's edges. The Common House Gecko (Figure 6E) utilizes arboreal microhabitats, which are often observed under the lights of houses and electrical posts. As a widespread species, this has been documented also in the peat swamp forest in Zamrud National Park in Indonesia (Leo et al 2020). The species can be distinguished from *Hemidactylus platyurus*, another common "house" gecko in the Philippines, by its round tail and smooth, non-frilled flanks (Brown et al 2013b). The Common House Gecko has a global range occurring in the tropical and subtropical regions and is found to be widespread in the Philippines (IUCN 2023).

Scincidae

Southern Burrowing Skink (Brachymeles orientalis [Brown & Rabor])

Only a single and adult individual of Southern Burrowing Skink (Figure 6F) was captured through a pitfall trap in the drained peat swamp forest areas of the LSBP. This skink species can also be found in various habitats, such as residential, disturbed, and secondary-growth forests at low elevations (Sanguila et al 2016). As a semi-fossorial species, it utilizes terrestrial microhabitats and is historically observed in soil, rotting logs, and forest floor detritus around tree buttresses (Siler and Brown 2010). Southern Burrowing Skink is endemic to Mindanao PAIC and is known to occur on the islands of Bohol, Samar, Leyte, Dinagat, Camiguin Sur, and Mindanao (Siler and Brown 2010).

Two-striped Mabouya (Eutropis multicarinata [Gray])

The Two-striped Mabouya (Figure 6G) was recorded only in the edge or peatland ecotone but was observed to be common, especially in secondary forest habitats. In addition, this species is also known to inhabit lowland primary forests, mid-montane forests, natural bonsai forests, and even altered habitats (eg, coconut plantations) (Barley et al 2020, Decena et al 2023). As observed, this skink species primarily prefers terrestrial microhabitats, usually encountered among leaf litter, soil, and tree buttresses/roots. However, the species may exhibit arboreality (Barley et al 2020), where it was observed to climb a small tree when disturbed or attempted to capture on one occasion in the study area. The Two-striped Mabouya can be distinguished by a set of characteristics, including a medium-sized body, keels on dorsal scales, and relatively uniform bronze dorsal and dark brown coloration of lateral body surface (Barley et al 2020). The Two-Striped Mabouya population has been taxonomically problematic with the probability of cryptic speciation (Barley et al 2013). In the Philippines, the species is known to occur in northeastern Mindanao, Dinagat, Samar, and Leyte (IUCN 2023).

Common Sun Skink (Eutropis multifasciata [Kuhl])

This disturbance-tolerant species was encountered in all the habitat types (peat swamp forests, grassland, agricultural, and edge/ecotone) in the LSBP. The Common Sun Skink (Figure 6H) appeared to be active both day and night, utilizing terrestrial microhabitats where individuals were frequently encountered in ground litter and grasses. The species can be noted for its polymorphism on lateral surfaces (bright green, orange, or yellow display surfaces), as well as the presence of multiple color patterns within the same population (Brown et al 2013b). This widespread habitat generalist species has an extensive geographic range occurring in most of the western landmasses of the Indo-Australian archipelago, southwest Asia, and northward into Indochina, and is also widely distributed in the Philippines (Sanguila et al 2016, IUCN 2023).

Emerald Tree Skink (Lamprolepis smaragdina philippinica [Mertens])

The Emerald Tree Skink (Figure 7A) was found to be locally abundant occurring in the peat swamp forests and edges/ecotone. This species can also be found in secondary forests, forest nurseries, riparian corridos, coastal areas, and agricultural areas (Brown et al 2013b, Sanguila et al 2016, Pitogo et al 2021). The species is highly arboreal and typically found active during the day in the trunks of coconut, and larger trees, while it can be found asleep at night inside trunk crevices, between branches, termite nests, high canopy, and vines. This species primarily feeds on invertebrates (Lepidoptera and Hymenoptera), but its diet also includes petals and nectar of flowers, fruit, bird eggs, and small vertebrates (Perry and Buden 1999, McCoy 2006). This disturbance-tolerant species is endemic and widely distributed in the Philippines (Venturina et al 2020).

Yellow-striped Slender Tree Skink (Lipinia pulchella pulchella Gray)

This diurnal species was found to be fairly common on the edges of the LSBP. The Yellow-striped Slender Tree Skink (Figure 7B) utilized arboreal microhabitats where individuals were often observed in tree trunks in secondary and plantation forests. A recent study by Decena et al (2023) also documented the species in lowland dipterocarp forests in the Babatngon Range in Leyte. The subspecies from the *Lipinia pulchella* complex, namely, *L. p. pulchella*, *L. p. taylori* (Negros Island), and *L. p. levtoni* (northern Luzon) were previously defined by Brown and Alcala (1980). This Philippine endemic species is distributed on the islands of Mindanao, Leyte, Samar, Luzon, and Polillo (Sanguila et al 2016).

Jagor's Sphenomorphus (Pinoyscincus jagori jagori [Peters])

This forest floor-dwelling species was encountered exclusively in the edges/ecotone of the LSBP. Moreover, Jagor's Sphenomorphus (Figure 7C) has been previously also documented in the riparian and interior of relatively undisturbed forests and disturbed forests (Sanguila et al 2016, Decena et al 2023). Pitogo et al (2021) documented species in high-elevation forests at 1,200masl. The species utilized terrestrial microhabitats, where individuals could be encountered in the leaf litters or hiding among piles of half coconuts in the study area. The

phylogenetic investigation of Linkem et al (2010) has shown three highly divergent species lineages for the populations Jagor's Sphenomorphus (or four with the populations of the subspecies *P. j. grandis*) from Mindanao and Luzon PAIC, thereby needing taxonomic revisions. Jagor's Sphenomorphus is known to be distributed, including the islands of Mindanao, Dinagat, and Siargao (Sanguila et al 2016).

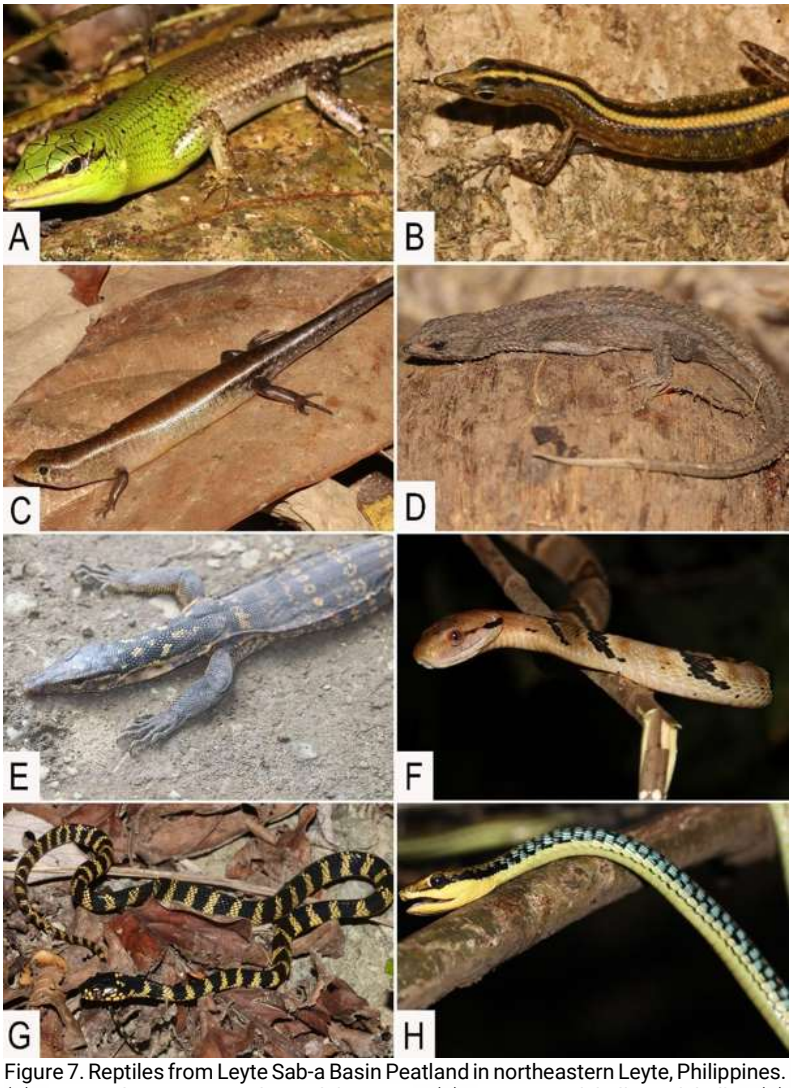

Figure 7. Reptiles from Leyte Sab-a Basin Peatland in northeastern Leyte, Philippines. (A) *Lamprolepis smaragdina philippinica*; (B) *Lipinia pulchella pulchella*; (C) *Pinoyscincus jagori jagori*; (D) *Tropidophorus grayi*; (E) *Varanus samarensis*; (F) *Boiga cynodon*; (G) *Boiga dendrophila latifasciata*; and (H) *Dendrelaphis marenae*.

Gray's Water Skink (Tropidophorus grayi Günther)

Gray's Water Skink (Figure 7D) was observed at the edges of the peatland, specifically in the coconut plantations. This semiaquatic aquatic species has also been previously encountered in primary and secondary forests (Supsup et al 2016, Decena et al 2023). It prefers cool or moist microhabitats such as rocks, piles of litter materials near water, and plant roots along streams (Ferner et al 2000, Gaulke 2011). At the edge of the peatland, individuals were encountered beneath the pile of moist coconut husks during the day or inside a shallow dug well. This Philippine endemic species is known to occur on the islands of Luzon, Polillo, Masbate, Panay, Negros, Cebu, Catanduanes, Leyte and Samar (IUCN 2023).

Varanidae

Samar Water Monitor (Varanus samarensis Koch, Gaulke and Böhme)

Samar Water Monitor (Figure 7E) is a reasonable generalist species inhabiting lowland and coastal areas, including forests, mangrove swamps, riparian habitats, fish ponds, and rice paddies (Koch et al 2010). Only two individuals of this varanid, an adult and a juvenile, were documented in the LSBP, which was brought by one of the locals. The individuals were caught through baited traps installed at the edge or peat swamp forest areas. According to the residents, this species is locally abundant in peat swamp forests, especially during the drier periods. However, like with many other varanids, the locals frequently poached Samar Water Monitor, which threatens its populations in the peatland. In addition, the presence of roads and vehicle traffic around the edges of the peatland, where a single roadkill individual was encountered, may also threaten the species. This species is endemic to the Mindanao PAIC and is known to be restricted to three islands only, namely, Samar, Leyte, and Bohol (Koch et al 2010).

Species Accounts: Reptilia (Snakes)

Colubridae

Dog-Toothed Cat Snake (Boiga cynodon [Boie])

Two individuals of Dog-toothed Cat Snake (Figure 7F) were encountered in the edge/ecotone of the peatland specifically in the secondary forest and mixed agroecosystems. Other authors reported encounters with these snake species in logged primary forests and riparian habitats (Brown et al 2013b, Sanguila et al 2016, Meneses et al 2022). The species utilized arboreal microhabitats where an adult individual (>1m in length) was observed climbing through the branches of trees 4 m from the ground, and another juvenile individual was found resting in the lower canopy of a cacao tree. This species varies considerably in coloration, ranging from blond to tan and patternless, to gray with brown and black irregular transverse saddles (Brown et al 2013b). In addition, members of the genus *Boiga* can be identified by having a laterally compressed body, distinctly enlarged head with a rounded snout, with large eyes and pupils oriented vertically (Meneses et al 2022). The Dog-toothed Cat Snake is widely distributed in Southeast Asia, and in the Philippines (Sanguila et al 2016, Leviton et al 2018).

Mangrove Snake (Boiga dendrophila latifasciata [Boie])

Only a single individual of the Mangrove Snake (Figure 7G) was encountered on the side of the road through secondary forests on the edge of the peatland. Unlike the dog-toothed cat snake, the species utilizes a terrestrial microhabitat observed on the ground among leaf litter. It can be distinguished from the rest of the *B. dendrophila* subspecies by having a dark dorsal coloration with yellow or white crossbands (≥ scale rows) from head to tail that widens laterally (Weilnell et al 2019). The Mangrove Snake is a Mindanao PAIC endemic species that occurs on the islands of Leyte, Mindanao, Samar, and Siargao (Leviton et al 2018).

Variable Reed Snake (Calamaria lumbricoidea H. Boie in F. Boie)

No live individual of Variable Reed Snake was encountered, but one roadkill was found along the primary/provincial road that passes through the edges of the LSBP. The adjacent land uses from which the individual was found were characterized by secondary forests and coconut plantations. This oviparous snake species mainly inhabits lowland and moist montane forests (IUCN 2023) and was also recently encountered in a dipterocarp forest in the eastern flank of Leyte Cordillera Mountain Range in Leyte (Decena et al 2023). The species can be identified by its small size and the presence of dark bands on the ventral surface of the body (Weilnell et al 2019). Variable Reed Snake is widespread in Southeast Asia and is found throughout the Mindanao PAIC islands in the Philippines (Sanguila et al 2016).

Philippine Rat Snake (Coelognathus erythrurus erythrurus [Duméril, Bibron and Duméril])

Only roadkill individuals of Philippine Rat Snake were found on primary roads around the LSBP. Also, another dead individual of this snake species was found in the middle of an unpaved road with a cut on its head, which was allegedly persecuted by one of the residents. The encounters of this snake species on roads circling the peatlands could indicate that it inhabits not only edges/terrestrial but possibly swampy areas also. This species was recently documented along an intermittent stream in a selectively logged primary forest in the Babatngon Range in Leyte (Decena et al 2023). This species, originally described from Java, Indonesia, has been documented in Mindanao PAIC islands, including Mindanao, Camiguin Sur, Samar, and Dinagat (Sanguila et al 2016).

Maren's Bronzeback (Dendrelaphis marenae Vogel and Van Rooijen)

This highly arboreal snake, the Maren's Bronzeback (Figure 7H), was found to be very common along the edges of the LSBP, primarily in coconut plantations and secondary vegetation. This species has also inhabited residential areas and forest edges (Brown et al 2013b). At night, individuals were frequently encountered asleep on the branches of second-growth trees and bushes, at least 1 m from the ground. Roadkill individuals of this species also tend to be common, suggesting that it utilizes terrestrial microhabitats as it moves through the different habitats. Vogel & van Rooijen (2008) recognized Maren's Bronzeback as an eastern form (Philippine and Sulawesi), splitting it from the western nominate population ([Common

Bronzeback *Dendrelaphis pictus* Gmelin]: Sunda shelf and Asian mainland). Maren's Bronzeback was historically documented from the northeast Mindanao faunal region (Ross and Lazell 1990), and also widely distributed in the Philippines (Leviton et al 2018).

Duméril's Wolf Snake (Lycodon dumerilii [Boulenger])

A single roadkill individual of Duméril's Wolf Snake was found on a single-lane paved road through secondary forests and agricultural areas at the edge of the LSBP. This species has also been documented in lowland dipterocarp forests in the Leyte and Mindanao (Relox et al 2011, Decena et al 2023). Individuals from these species can be distinguished by the presence of dark crossbands in the dorsal side of the body and tail (Weilnell et al 2019). Duméril's Wolf Snake is endemic to the Mindanao PAIC and is known to occur on the islands of Basilan, Dinagat, Leyte, Mindanao, Samar, and Siargao (Leviton et al 2018).

Muller's Wolf Snake (Stegonotus muelleri Duméril, Bibron and Duméril)

This large species of rat snake was encountered during the night survey at the edges of the peatland, specifically the grassland area and unpaved road. The species is known to be an upland forest-dwelling species inhabiting dipterocarp forests and limestone or karst forests (Pitogo et al 2021, Cuta et al 2022, Decena et al 2023), and the present survey shows that peatland is its other preferred habitat. This species utilized terrestrial and aquatic microhabitats of which individuals could be encountered slithering through the grasses or found in puddles on unpaved roads. Local fishermen in the peatland often observed the species preying on or consuming catfish (*Clarias* sp.) that has been hooked on. In addition, this species is threatened by human persecution due to fear within the local community, as well as mortality from vehicle traffic. Muller's Wolf Snake (Figure 8A) is a unique and of true Papuan biogeographical origin that is endemic to Mindanao PAIC, occurring on the islands of Dinagat, Leyte, Mindanao, and Samar (Leviton et al 2018).

Elapidae

Samar Cobra (Naja samarensis Peters)

A single roadkill individual of this venomous cobra species was found on a main road in the southern portion of the LSBP. This species is known to inhabit a wide range of habitats, such as moist forests, karst ecosystems, forest edges, and even highly altered habitats, including coconut plantations, rice fields, and settlements (IUCN 2023). Samar Cobra is endemic to the Philippines and occurs in Bohol, Camiguin Sur, Dinagat, Leyte, Mindanao, and Samar (Leviton et al 2018).

Lamprophiidae

Philippine Shrub Snake (Oxyrhabdium modestum [Duméril])

Only roadkill individuals of Philippine Shrub Snake have been recorded in the vicinity of LSBP. This species is commonly encountered in habitats like mixed secondary forests, selectively logged forests, and riparian areas (Sanguila et al 2016, Pitogo et al 2021, Decena et al 2023). It has been observed in various microhabitats, including leaf litter, fern, and small samplings (Sanguila et al 2016). Characteristics appearance of this species include brown or reddish-brown coloration of the dorsal side surface of the head, body, and tail, and the juveniles have a distinct white nuchal collar (Weilnell et al 2019). Philippine Shrub Snake is a Mindanao PAIC endemic species that is known to occur on the islands of Basilan, Bohol, Dinagat, Leyte, Mindanao, Negros Samar, and Camiguin Sur (Leviton et al 2018).

Figure 8. Reptiles from Leyte Sab-a Basin Peatland in northeastern Leyte, Philippines. (A) *Stegonotus muelleri*; (B) *Psammodynastes pulverulentus*; (C) *Ramphotyphlops* sp.; (D) *Tropidolaemus philippensis*; and (E) *Cuora philippinensis*.

Common Mock Viper (Psammodynastes pulverulentus [Boie])

Two individuals of the Common Mock Viper (Figure 8B) were encountered; one was from the peat swamp forests and the other from the grassland areas. This species was recently documented in Leyte in the lowlands (145masl) up to an elevation of 1101masl (Decena et al 2023). It utilizes arboreal microhabitats in the peatland, such as edges and lower canopy of trees. Furthermore, the species has also been observed in tree holes, streamside vegetation, saplings, abaca leaves, and ground in forest ecosystems (Brown et al 2013b, Sanguila et al 2016, Pitogo et al 2021). Common Mock Viper is widespread in Southeast Asian countries and occurs in most of the Philippine Islands (Leviton et al 2018).

Typhlopidae

Ramphotyphlops sp.

Two individuals of *Ramphotyphlops* sp. (Figure 8C) were captured in the LSBP area, one in the edge and the other in the peat swamp forest area. This blind snake species closely resembles the Cuming's Blind Snake (*Ramphotyphlops cumingii* [Gray]) that is currently known to occur on the islands of Bohol, Cebu, Marinduque, Masbate, Mindanao, Negros, Polillo, Sibuyan, and Sicogon (Leviton et al 2018). The documented individuals in the peatland area have a total body length ranging from 330-390mm, with a rounded head, a tail that has a pointed needle-like part, smooth scales, and a brown coloration on the dorsal surface extending from head to tail. As observed, the species is arboreal, with individuals found among the leaves of *Pandanus* sp. (2m from the ground), and another was found while falling from a small branch of a Lanipau tree (3m from the ground). Furthermore, there is a need for taxonomic study to identify Leyte's blind snake species properly.

Viperidae

South Philippine Temple Pit Viper (Tropidolaemus philippensis [Gray])

Two individuals of the South Philippine Temple Pit Viper (Figure 8D) were encountered at night on the edge of the peatland, which is characterized by secondary forest. Decena et al (2023) recently documented this snake species in lowland dipterocarp forests and disturbed habitats, such as coconut plantations. It inhabits arboreal microhabitat, with individuals typically found on tree branches around 3 m from the ground. Observed individuals exhibited turquoise green or green body coloration, with dark or brown and reddish hues at the tip of the tail (Decena et al 2023). This Mindanao PAIC endemic snake species is restricted to the islands of Dinagat, Leyte, Mindanao, and Samar (Leviton et al 2018).

Species Accounts: Reptilia (Turtles)

Bataguridae

Philippine Box Turtle (Cuora philippinensis Blanck, Gaillard, Protiva, Wheatley, Shi, Liu, Ray and Anders)

The Philippine Box Turtle (Figure 8E) was observed in disturbed habitats within LSBP, such as in the agricultural and edge of the peatland. This widespread turtle species can also be found frequently in other habitats such as streams and rivers, man-made basins, and open fields (Diesmos et al 2008, Mcleod et al 2011, Devan-Song & Brown 2012). The species utilizes aquatic microhabitats, with individuals often found trapped in shallow dug wells or along canals in rice field areas of the peatland. Informal interviews with the local people show that the turtle species tend to be locally abundant along the edges of peat swamp forest areas during the fruiting season of *Pandanus* sp. The individuals of this species could be observed aggregating or hiding among understorey vegetation or leaf liters as they feed on fallen ripened fruits.

Endemism

The overall herpetofaunal endemicity in the LSBP was 64% (*n*=25), with the highest number of endemic species for lizards (10), followed by frogs (8) and snakes (6) (Figure 9). Moreover, 38% of the species are endemic to the Mindanao PAIC of which Leyte is part. This includes five frogs: Guenther's Forest Frog, Mindanao Fanged Frog, Mindanao Horned Frog, Mindanao Cross Frog, and Leyte Tree Frog; four lizards: White-spotted Flying Lizard, Southern Burrowing Skink, Two-striped Mabouya, and Samar Water Monitor; and six snakes: Mangrove Snake, Duméril's Wolf Snake, Muller's Wolf Snake, Samar Cobra, Philippine Shrub Snake, and South Philippine Temple Pit Viper.

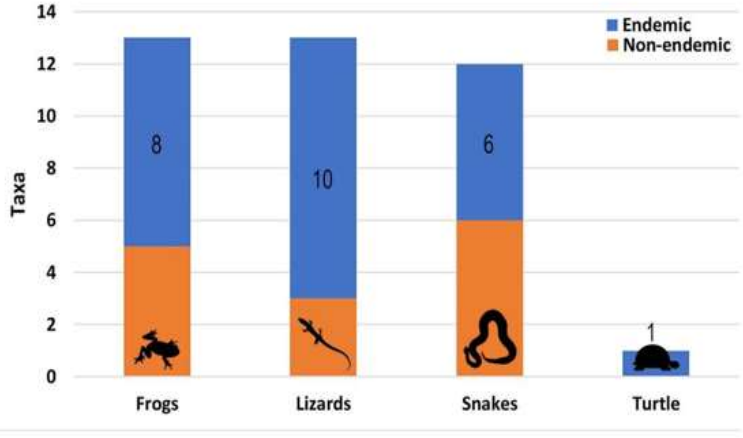

Figure 9. The number of endemic herpetofauna species in Leyte Sab-a Basin Peatland in northeastern Leyte, Philippines.

Habitat and Microhabitat Use

The broad habitat types sampled in the LSBP included peat swamp forests, grassland, agricultural land, and peatland edges or ecotone (Figure 2). It was found in this study that the majority (69%) of the amphibian species occurred within the peatland area (peat swamp, grassland, and agricultural), while 31% have been documented only in the edge or ecotone of the peatland. Though some species were found across multiple habitat types, amphibians such as the Small Disked Frog, Common Puddle Frog, Mindanao Cross Frog, and Leyte Tree Frog were exclusively documented in the less disturbed, original peat swamp forest habitats (Table 1). For reptiles, 34% of the species utilized multiple habitat types. Meanwhile, it should be noted that almost all (92%) of the species were at least utilizing peatland edge habitats, and more than half (62%) of them were only documented in these habitats (Table 2). The most abundant species found in the edge of the peatland or ecotone were *Bronchocela* sp., Two-striped Mabouya, Common Sun Skink, Emerald Tree Skink, and Maren's Bronzeback.

The microhabitats for herpetofauna were categorized as arboreal, terrestrial, and aquatic. About 38% of the amphibian species utilized more than one microhabitat, particularly from the family Dicroglossidae (Luzon Wart Frog, Small Disked Frog, and Mindanao Fanged Frog), which utilized both terrestrial and aquatic microhabitats. Also, 31% utilized terrestrial microhabitats, including endemic species such as Mindanao Horned Frog, and Painted Narrowmouth Toad, while 23% utilized arboreal microhabitats with Guenther's Forest Frog, and Leyte Tree Frog as frequently observed species (Table 1). For reptiles, it appears that a similar proportion of 46% utilized arboreal, and also terrestrial microhabitats (Table 2). Notable reptile species utilizing arboreal microhabitats included *Bronchocela* sp., Emerald Tree Skink, Yellow-striped Slender Tree Skink, and Maren's Bronzeback, and while those that utilized terrestrial microhabitats may include the most commonly encountered lizard species such as Two-striped Mabouya, Common Sun Skink, and Gray's Water Skink.

DISCUSSIONS

Leyte Island, as part of the Mindanao PAIC biogeographic region, is home to many endemic amphibians and reptiles. However, research efforts concerning these important groups of animals remains limited on the island (Mallari et al 2013). Much recently, only a handful of herpetological studies and surveys have been conducted in Leyte, including by Mallari et al (2013), Decena et al (2020), and Decena et al (2023); however, these studies have focused mainly on high elevation forest habitats in mountain ranges. Interestingly, other unique habitats are also present in the lowlands of the island, specifically the LSBP, which is regarded as a unique wetland ecosystem. The LSBP in Leyte, as well as peatlands from other parts of the country, remains virtually unexplored in terms of the herpetofaunal communities. This recent herpetological survey in the LSBP contributes significantly to the scanty information about the herpetological community and diversity in peatlands or peat swamp forests in the country. This recent study particularly provides new information on species occurrence or distribution, endemicity, as well as habitat and microhabitat use. The survey of various habitats in the peatland has yielded a total of 39 herpetofauna species which comprise 13 amphibians and 26 reptiles. The

fieldworks were generally conducted at the onset of the dry periods, and there could likely be additional species that will be documented when future studies are conducted especially during the wet season.

Compared with previous herpetofaunal studies and surveys in Leyte, the number of amphibian species (*n*=13) documented in the LSBP was found to be lower than those of Mallari et al (2013) who recorded 21 species in Nacolod Mountain Range, Decena et al (2023) with 20 species in Leyte Cordillera Mountain Range and Babatngon Range, and Denzer et al (1994) with 19 species documented in Mt. Pangasugan and western part of Leyte. The number of amphibians species from the peatland appeared to be comparable to the study of Decena et al (2020) with 16 species from Babatngon Range in Leyte, and Almeria & Nuñeza (2013) with 13 identified species from swamp forests of Agusan Marsh, Agusan del Sur, Mindanao (Table 3). On the other hand, the number of amphibian species recorded in the present study was higher than in the recent study in LSBP, also by Densing and Matutes (2024), with only 7 species. In terms of reptile species, a larger number were recorded from the studies of Denzer et al (1994) (*n*=50), Mallari et al (2013) (*n*=42), and Decena et al (2023) (*n*=30), but fewer in the study of Densing and Matutes (2024) (*n*=17) (Table 4). The previous and present studies consistently documented many of the herpetofauna species. However, one amphibian (Mindanao Cross Frog) and one reptile (Mangrove Snake) were only reported in this present study in LSBP, where the unsuccessful encounter of these species from previous surveys could be attributed to their low population abundance, patchy distribution, highly specialized microhabitat requirements, and high mobility (Decena et al 2023). Also, unsuccessful documentation could result from insufficient sampling efforts (Hanson and McElroy 2015) or unideal weather conditions during surveys. Moreover, it can be noted that despite the similarity in the environment, only four species in terms of amphibians (Cane Toad, Small Disked Frog, Common Puddle Frog, and Common Tree Frog) have been documented in both LSBP of Leyte and Agusan Marsh of Mindanao.

Even though the LSBP has been heavily subjected to habitat degradation and modification in the past decades, it has served as an important refuge for several endemic amphibians, especially reptiles. The present survey reveals that the overall endemicity in the study area is about 64%, with an endemicity of 61 and 65% for amphibians and reptiles, respectively. The level of amphibian endemicity of the peatland was found to be similar for amphibian communities in the tropical rainforests of Babatngon Range in Leyte (56%, Decena et al 2020) and even greater than in swamp and peat swamp forests of Agusan Marsh in Mindanao (41%, Almeria and Nuñeza 2013). Meanwhile, reptile endemicity in the peatland was comparatively lower than the recently documented endemicity (70%) in the Leyte Cordillera Mountain Range and Babatngon Range by Decena et al (2023). Nevertheless, it was notable that lizards had the highest number of endemic species in the peatland, indicating a higher conservation value of this wetland ecosystem for this group of species. These endemic species are a very important indicator of ecosystem health where their absence could indicate habitat disturbance (Nuñeza et al 2010). Accordingly, many of the endemic herpetofaunal species in the peatland have been encountered in less disturbed habitats, such as within peat swamp forests and secondary forest areas along the peatland edges/ecotone. Such noteworthy herpetofaunal species in LSBP may include the Mindanao Fanged Frog, Philippine Sailfin Lizard, and Samar Water Monitor, because, at the same time, they are threatened by illegal poaching by the local people.

Table 3. Amphibians recorded in the study area (LSBP) and from previous studies (marked by x) are in columns.

Amphibians	Leyte					Mindanao	
	Denzer et al 1994	Mallari et al 2013	Decena et al 2020	Decena et al 2023	Densing and Matutes 2024	Almeria and Nuñeza 2013	This study
Bufonidae							
Pelophryne lighti	x	x		x			
Rhinella marina	x		x	x	x	x	x
Ceratobatrachidae							
Platymantis bayani		x					
Platymantis corrugatus	x	x	x	x			
Platymantis dorsalis	x						
Platymantis guentheri	x	x		x			x
Platymantis rabori		x					
Platymantis sp.		x					
Platymantis sp.		x					
Platymantis sp.			x				
Platymantis sp.1				x			
Platymantis sp.2				x			
Platymantis sp.3				x			
Dicroglossidae							
Fejervarya moodiei	x	x		x		x	
Fejervarya vittigera		x	x	x	x		x
Limnonectes leytensis	x	x	x	x		x	x
Limnonectes magnus		x	x	x			x
Limnonectes parvus						x	
Limnonectes visayanus	x						
Limnonectes cf. *visayanus*			x				
Occidozyga laevis	x	x	x	x	x	x	x
Megophryidae							
Megophrys stejnegeri	x	x	x	x			x
Microhylidae							
Kalophrynus sinensis	x	x	x	x	x		x
Kaloula baleata						x	
Kaloula conjuncta						x	
Kaloula picta	x		x	x	x		x
Kaloula sp.		x					
Kaloula sp.			x				
Oreophryne anulata							x
Oreophryne sp. 1						x	
Oreophryne sp. 2						x	
Ranidae							
Hylarana erythraea	x		x	x	x		x
Pulchrana grandocula	x	x	x	x			
Sanguirana everetti						x	
Sanguirana mearnsi	x	x		x			
Staurois natator	x	x	x	x			

Table 3. continued

Amphibians	Leyte					Mindanao	This study
	Denzer et al 1994	Mallari et al 2013	Decena et al 2020	Decena et al 2023	Densing and Matutes 2024	Almeria and Nuñeza 2013	
Rhacophoridae							
Nyctixalus spinosus	x	x		x			
Philautus acutirostris						x	
Philautus leitensis	x	x	x	x			x
Philautus poecilus						x	
Philautus sp.						x	
Polypedates leucomystax	x	x	x	x	x	x	x
Rhacophorus appendiculatus		x				x	
Rhacophorus bimaculatus		x	x	x		x	
Rhacophorus pardalis		x					

As expected, most (69%) of the amphibian species were encountered directly within the peatland area among the peat swamp forest, grassland, and agricultural areas. The presence of many amphibians in the peatland can be strongly attributed to the waterlogged conditions with the presence of pools and canals, which serve as an important breeding habitat for them (Inger and Stuebing 1990, Jongsma et al 2014). For example, frequently encountered species such as Luzon Wart Frog, and Common Puddle Frog are known to deposit their eggs directly in standing bodies of water (IUCN 2023), and these species were often seen in water buffalo wallows or pools of water in the peatland. Some species, especially Common Green Frog and Common Tree Frog, were observed to occur in multiple habitats, indicating their generalist characteristics, and they are also known to be tolerant to disturbance (Sanguila et al 2016, Decena et al 2020). On the contrary, species including Small Disked Frog, Common Puddle Frog, Mindanao Cross Frog, and Leyte Tree Frog were exclusively encountered in peat swamp forests, suggesting that these species only prefer less disturbed environments with greater habitat structural complexity. As for reptiles, almost all of the species were at least utilizing peatland edges or ecotone areas as their habitat. The greater diversity in these areas in the peatland can be explained by spatial heterogeneity (Risser 1995), which can be characterized by the variability in the habitat types and greater habitat quality. For example, the edges and ecotones in the study area were usually characterized by a mosaic of grassland, bushes, agroecosystems, and secondary forests. Moreover, the presence of the majority of the reptile species in the edges or ecotone can be alternatively explained by their need for warm sites, varied topography, and as well well-drained soils (Edgar et al 2010).

Table 4. Reptiles recorded in the study area (LSBP) and from previous studies in Leyte (marked by x) are in columns.

Reptiles	Denzer et al 1994	Mallari et al 2013	Decena et al 2023	Densing and Matutes 2024	This study
LIZARDS					
Agamidae					
Bronchocela sp.	x	x	x	x	x
Draco bimaculatus	x		x		
Draco cyanopterus		x			
Draco mindanensis		x			
Draco ornatus			x		x
Draco reticulatus				x	
Gonocephalus interruptus	x	x	x		
Hydrosaurus pustulatus	x	x	x	x	x
Gekkonidae					
Cyrtodactilus annulatus	x		x		
Cyrtodactilus gubaot		x	x		
Gehyra mutilata	x				
Gekko gecko	x		x	x	x
Gekko intermedium	x				
Gekko mindorensis	x				
Gekko monarchus	x				
Hemidactylus frenatus	x	x	x		x
Hemiphyllodactylus typus				x	
Lepidodactylus herrei	x				
Pseudogekko pungkaypinit		x	x		
Scincidae					
Brachymeles cf. *talinis*		x			
Brachymeles orientalis	x	x			x
Brachymeles paeforum		x			
Brachymeles samad	x				
Brachymeles samarensis	x				
Brachymeles sp.		x			
Emoia atrocostata	x				
Eutropis indeprensa	x				
Eutropis multicarinata	x	x	x	x	x
Eutropis multifasciata	x		x	x	x
Lamprolepis smaragdina philippinica	x		x	x	x
Lipinia pulchella pulchella	x		x		x

Table 4. continued

Reptiles	Denzer et al 1994	Mallari et al 2013	Decena et al 2023	Densing and Matutes 2024	This study
Otosaurus cumingii	x	x			
Parvoscincus steerei	x	x			
Pinoyscincus coxi coxi	x	x	x		
Pinoyscincus jagori jagori	x	x	x		x
Pinoyscincus llanosi	x		x		
Pinoyscincus mindanensis	x	x			
Sphenomorphus acutus	x	x			
Sphenomorphus fasciatus		x			
Sphenomorphus variegatus	x	x			
Tropidophorus grayi	x		x		x
Varanidae					
Varanus cumingi	x	x			
Varanus samarensis				x	x
SNAKES					
Colubridae					
Ahaetulla prasina preocularis	x	x			
Boiga cynodon	x	x	x		x
Boiga dendrophila	x				
Boiga dendrophila latifasciata					x
Calamaria gervaisi	x				
Calamaria lumbricoidea	x	x	x		x
Chrysopelea paradisi	x				
Coelognathus erythrurus erythrurus	x	x	x	x	x
Cyclocorus lineatus				x	
Cyclocorus nuchalis taylori	x	x			
Dendrelaphis marenae				x	x
Dendrelaphis philippinensis	x	x			
Lycodon aulicus		x			
Lycodon capucinus	x				
Lycodon dumerilii			x		x
Lycodon ferroni		x			
Oligodon modestum	x	x		x	
Stegonotus muelleri	x		x	x	x
Elapidae					
Naja samarensis	x	x		x	x
Ophiophagus hannah				x	
Lamprophiidae					
Oxyrhabdium modestum	x	x	x		x

Table 4. continued

Reptiles	Denzer et al 1994	Mallari et al 2013	Decena et al 2023	Densing and Matutes 2024	This study
Psammodynastes pulverulentus	x	x	x		x
Natricidae					
Rhabdophis auriculatus auriculatus		x	x		
Tropidonophis dendrophiops		x	x		
Tropidonophis negrosensis		x			
Pareidae					
Aplopeltura boa		x			
Pythonidae					
Malayopython reticulatus	x	x			
Typhlopidae					
Indotyphlops braminus	x				
Ramphotyphlops sp.					x
Typhlops sp.		x			
Viperidae					
Trimeresurus flavomaculatus	x	x			
Trimeresurus cf. *flavomaculatus*			x		
Tropidolaemus philippensis			x		x
Tropidolaemus wagleri	x	x			
TURTLES					
Bataguridae					
Cuora philippinensis	x	x	x	x	x

Microhabitat availability may influence the occurrence and distribution of herpetofauna species (Decena et al 2023). As ectothermic animals, their body temperature is not derived from metabolic processes but rather from the surrounding environment, resulting in their diverse microhabitat utilization (Dickerson 2001). Moreover, variations in microhabitat use in herpetofauna can also be directly rooted in the differential use of microhabitats for breeding, foraging, and refuge sites (Duellman and Trueb 1994). The present survey revealed that many amphibian species from the peatland use at least one microhabitat. Such multiple microhabitat use has also been observed for amphibians in Leyte Cordillera Mountain Range and Babatngon Range in Leyte (Decena et al 2023) and in Mount Hilong-hilong, Agusan Del Norte, Eastern Mindanao (Plaza and Sanguila 2015). Notably, amphibian species in the peatland using terrestrial and aquatic microhabitats were those from the family Dicroglossidae. For example, amphibian

Luzon Wart Frog was frequently encountered in terrestrial microhabitats among grasses and bare peat soil and as well often congregating in aquatic microhabitats (eg, water buffalo wallow), likely in finding mates and egglaying. Meanwhile, utilization of multiple microhabitats in reptiles in the peatland was not common. Instead, many of the species use either arboreal or terrestrial microhabitats. Many of the arboreal species utilized tree trunks, saplings, tall grasses, small branches, and canopy, mainly for resting and sleeping. Most notable reptile species in the peatland may include endemic lizards such as the Emerald Tree Skink and Yellow-striped Slender Tree Skink. The strict arboreal microhabitat use of these species could suggest that they are more sensitive to habitat destruction, as they may be unable to utilize other microhabitats (eg, ground or aquatic) (Decena et al 2023). Lastly, with those preferred microhabitats and as well broader habitats, less disturbed and structurally diverse habitats, such as peat swamp forests and edges/ecotones in the peatland, should be given attention for conservation to ensure the survival of herpetofauna species.

CONCLUSIONS AND RECOMMENDATIONS

The current survey highlights LSBP as an important habitat for herpetofauna species. Despite that large portions of the peatland have been deforested and degraded, it still serves as an important refuge for many endemic species of amphibians and reptiles that are mostly inhabiting the remaining peat swamp forest areas as well as peatland edges and ecotones. Therefore, it is highly recommended that the remaining peat swamp forests be protected and the degraded peatland and ecotone areas be reforested with indigenous tree species, which will lead to the persistence of herpetofauna species. Finally, future works are also needed for the herpetofauna species of the peatland in terms of ecology, population dynamics, or taxonomy.

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AUTHOR CONTRIBUTIONS

All the authors contributed significantly to the development of the manuscript. SCPD, FICB, and LAFD designed the study. SCPD and FICB collected the field data, and all the authors performed analyses. SCPD and FICB prepared the initial manuscript draft, and all authors commented on previous versions. All authors read and approved the final manuscript.

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AVAILABILITY OF DATA AND MATERIALS

The raw data associated with this study are available from the corresponding author upon reasonable request.

ETHICAL CONSIDERATION

The study followed the Wildlife Gratuitous Permit (DENR8- GP No. 2024-07).

COMPETING INTEREST

There are no competing interests to disclose.

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