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Research Article

Diversity and Distribution of Anuran fauna in Gibbon Wildlife Sanctuary, Assam, India

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ABSTRACT

Amphibians play a major role in maintaining ecological balance as they are key indicators of environmental health and contribute significantly to both pest control and nutrient cycling within ecosystems. Despite their importance, amphibians are increasingly threatened by habitat loss, pollution, and climate change. We conducted survey from June 2022 to February 2023 in the Gibbon Wildlife Sanctuary, aimed to document the diversity of anuran species and evaluate the conservation challenges they face. Over the course of the study, 14 distinct anuran species were identified, representing 5 families and 11 genera with 1 new record from Assam. All recorded species were classified as "Least Concern" according to the IUCN Red List criteria. However, the sanctuary's amphibians are under threat from the expansion of tea plantations, agricultural development, and increasing human populations.

Key words: Gibbon Wildlife Sanctuary, Amphibian, Anuran, Diversity, Microhabitat, Conservation threats.

INTRODUCTION

Amphibians which are considered as best biological indicator are used as a model tool to study and present the issues of declining population in an ecosystem and they are more endangered to decline than other vertebrate taxa (Bishop *et al.,* 2012; Pimm *et al.,* 2014; Stuart *et al.,* 2004; Wake & Vredenburg, 2008). It is seen that amphibians are declining all over the world (Blaustein, 1990; Pechmann and Wilbur, 1994; Hof *et al.,* 2011). Amphibian conservation is an alarming factor, firstly because of their diverse taxonomic group playing an important role in environment with their unique bio-indicator features, secondly a disturbance in their population will have far-reaching and detrimental effects on biodiversity and lastly they are the ecological indicators of a pristine environment (Halliday, 2008). Rapid urbanization that results in changes to land use, habitat loss and modification, contamination of available habitats, and traffic noise are some of the main concerns facing anurans in human-dominated ecosystems (Aravind & Gururaja, 2011). Studying species richness helps us to understand the baseline of ecology, organisms distribution, concept of co-existence, and prepare conservation strategies (Fu *et al.,* 2006; Hu *et al.,* 2011). Protection of microhabitat is important for amphibian conservation since patch quality describes the species microhabitat (Thorpe *et al.,* 2018). Class Amphibia consists of three extant orders: Anura (frogs) with 7,586 species, Caudata (salamanders) with 810 species, and Gymnophiona (caecilians) with 221 species (globally) (Frost, 2023). In India, the amphibian fauna comprises 454 species, including 411 species in the order Anura, 2 species in the order Caudata, and 41 species in the order Gymnophiona (Dinesh *et al.,* 2023). Recent studies suggest that many amphibian species remain undiscovered, highlighting the potential for new species identification (Das *et al.,* 2004; Sengupta *et al.,* 2008; Biju *et al.,* 2011, 2014; Howlader *et al.,* 2015; Das *et al.,* 2019). Also, new species have been described from the neighbouring states of Assam (Biju *et al.,* 2010; Purkayastha & Matsui, 2012; Mahony *et al.,* 2013; Boruah *et al.,* 2023a, Boruah *et al.,* 2023b). Gibbon Wildlife Sanctuary (GWS) situated in Jorhat district of Mariani range falls in the plains of Brahmaputra River. Although numerous studies have been conducted in Gibbon Wildlife Sanctuary (Srivastava *et al.,* 2001; Senthilkumar *et al.,* 2006; Das *et al.,* 2009; Devi and Saikia, 2010; Chetia and Kalita, 2012; Sharma *et al.,* 2021; Sharma and Sinha, 2022; Stotrabhashyam *et al.,* 2023) there remains a lack of published data specifically on anuran diversity. Therefore, in this paper we prepare a bio-inventory of anurans found in the habitat of Gibbon Wildlife Sanctuary as well as to document the conservation threats.

MATERIALS AND METHODS

Study Area

Gibbon Wildlife Sanctuary is situated in Mariani range (26°40’ –26°45’ N, 94°20’ – 94°25’ E) close to Naga hills in Jorhat district. Falling under the Northeast Upper Brahmaputra valley zone, the sanctuary covers an area of 20.98 sq km with an average elevation varying between 100-120m with presence of many temporary rain pool and streams after the monsoon season. It is about 22 km from the Jorhat town. The sanctuary, formerly known as Hollongapar Reserve Forest, was designated as a Wildlife Sanctuary in 1997. Initially named after the dominant tree species, Holong (*Dipterocarpus macrocarpus*), it was later renamed as Gibbon Wildlife Sanctuary in 2004. Within the sanctuary, the Bhogdoi river acts as a barrier by flowing from Nagaland in South to Assam in North-West direction. For administrative management, the sanctuary is organized into five separate compartments, each containing a forest camp:

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Madhupur, Teteliguri, Kotahlguri, Bajdiha, and Kaliapani. A 1.65 km broad gauge railway track, part of Mariani-Dibruagarh route passes through the sanctuary. Gibbon wildlife sanctuary is famous for the presence of the Hoolock Gibbon including six other primate species- Capped Langurs, Slow Loris, Stumptail macaques, Pig-tail macaques, Assamese macaques, and Rhesus macaques. *Mesua ferrea, Castanopsis indica, Terminalia belerica, Artocarpus chaplasa*, *Vatica lancefoli, Canarium resiniferum* are some of the dominant plant species found in the sanctuary.

Vegetation and Climate

Gibbon Wildlife sanctuary consists of semi-evergreen forest types scattered with wet evergreen forest (Champion and Seth, 1968) with temperature ranging from 9-34 °C. The area is surrounded by mosaic of habitat such as dense vegetation, Tea plantation, agriculture, and human habitation.

Sampling

We carried our field survey from June 2022- February 2023 in Gibbon Wildlife Sanctuary, Assam, India. From the perspective of different microhabitats observed in the study site, we carried our sampling in five microhabitats such as in topsoil (bare land, grassland), Wetlands (Grassy wetland, Swamps and marshes, saturated land), understories (bamboos, shrubs and small trees), Tea gardens and human habitation. Surveys were made in the early morning and late evening. Amphibians were searched intensively along the forest trail, near water bodies, beneath rocks and logs by turning, peeling barks, digging leaf litters and excavating burrows employing visual encounter survey method. Specimens were collected using the handpicked method, and live photographs were captured using a Nikon D5600 model with an 18-55 mm lens. Adults were captured by hand during nocturnal surveys using flashlights to assist in detection (Inger and Dutta, 1986). All observed amphibians were subsequently released into their natural habitat after taking photographic records and morphometric measurements and identified up to species level based on morphology using literature (Boulenger, 1890, 1920, Chanda 1990, 1994, 2002; Ahmed *et al.,* 2009; Mathew & Sen, 2010; Howlader, 2011; Hasan *et al.,* 2014).

Data Analysis:

Species richness was assessed according to microhabitat preferences, and diversity indices were calculated using the Past Version 3.0 software (Hammer, 2017). We have taken four diversity indices across various microhabitats. We calculated index of Dominance (D) for calculating dominance in the community, for diversity we analyzed Shannon-Weiner index (H′) = – Σ pilnpi; where pi = proportion of total sample belonging to i^{th} species, ln= natural logarithm (Shannon & Weaver 1949). Evenness was calculated using the formula: Evenness or Equitability (J') = H′/Hmax where Hmax= lnS, S = number of species, H′ = Shannon–Wiener Diversity (Pielou 1969). Margalef's richness index (DMg) = (S-1)/lnN, where S = total number of species, N = total number of individuals in the sample, ln= Natural logarithm (Margalef, 1958).

RESULTS AND DISCUSSIONS

The study conducted at Gibbon Wildlife Sanctuary documents a total of 3352 individuals of 14 anuran species in the inventory. Our anuran data contributed 3.4% of anurans found in India (Dinesh *et al.,* 2023), 17.9% of anurans recorded from Northeast India (Sen, 2004), 25% of anurans recorded from Assam (Sengupta *et al.,* 2010). Our results reveal a significant diversity of anuran species within the Gibbon Wildlife Sanctuary. We recorded 70% of anurans documented in Amchang Wildlife Sanctuary (Purkayastha *etl al.,* 2020) and 60.86 % reported from Barail Wildlife Sanctuary (Das *et al.,* 2009). During the study period, all the recorded 14 anuran species belong to five families and eleven genera. The five families are represented by Bufonidae, Dicroglossidae, Ranidae, Rhacophoridae and Microhylidae. Family-wise species contribution has been shown in Fig 1. Family Dicroglossiade contributed maximum (36%) species richness (s=5) followed by Rhacophoridae (29 %) represented by 4 species (s=4), Ranidae (21%) represented by 3 species (s=3), Bufonidae and Microhylidae both contributed 7% of species richness represented by 1 species each. All 14 recorded anuran species are classified as "Least Concern" (LC) according to the IUCN Red List (IUCN, 2023) (Table 1). In our study, we have recorded *Minervarya asmati* for the first time in Assam.

Table 1. Checklist of Anurans encountered in Gibbon Wildlife Sanctuary along with IUCN conservation status. Abbreviations used : TS- Topsoil, WT- Wetlands, UT- Understory, TG- Tea Garden, HH- Human Habitation, LC- Least Concern**.**

Family	Scientific Name	Indian Common Name	Habitat	IUCN Status
Bufonidae	Duttaphrynus melanostictus (Schneider, 1799)	Indian Common True Toad	TS, WT, UT,TG,HH	LC
Microhylidae	Microhyla mymensinghensis (Hasan, Islam, Kuramoto, Kurabayashi and Sumida, 2014)	Mymensingh Chorus frog	TS, HH	LC
	Scientific Name	Indian Common Name	Habitat	IUCN Status

	Hoplobatrachus tigerinus (Daudin, 1802)	**Indian bull Frog**	**WT, UT, TG, HH**	**LC**
Dicroglossidae	Euphlyctis adolfi (Gunther, 1860)	Adolf Skipper Frog	WT, UT,TG,HH	LC
	Minervarya asmati (Howlader, 2011)	Bangladeshi Cricket Frog	TS, WT,UT,HH	LC
	Minervarya pierrei (Dubois, 1975)	Pierrei Cricket Frog	TS,WT,UT,TG,HH	LC
	Fejervarya sp		TS,WT,UT,TG,HH	
Ranidae	Humerana humeralis (Boulenger, 1887)	Northern Caped Frog	WT,UT	LC
	Hylarana leptoglossa (Cope, 1868)	Cope's Assam Frog	WT	LC
	Hylarana tytleri (Theobald, 1868)	Yellow-striped frog	WT,TG	LC
Rhacophoridae	Polypedates teraiensis (Dubois, 1987)	Assam Whipping Frog	UT	LC
	Polypedates leucomystax (Gravenhorst, 1829)	Common Indian Whipping Frog	UT	LC
	Raorchestes sp		UT	
	Feihyla sp		UT	

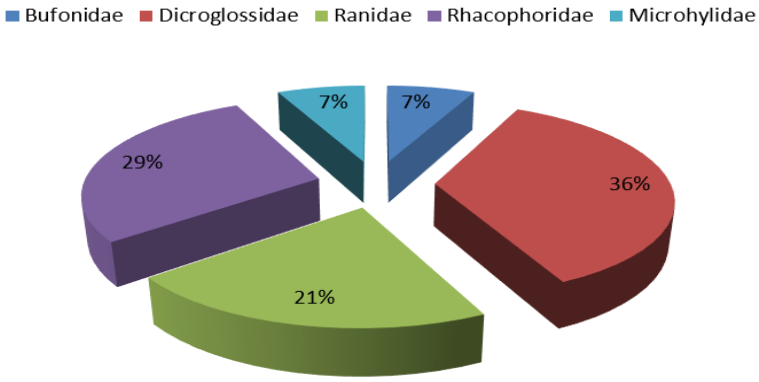


Figure 1. Family-wise species composition of Anurans in Gibbon wildlife

1. *Duttaphrynus melanostictus*

2. *Euphlyctis adolfi*

3.*Hoplobatrachus tigerinus*

4. *Fejervarya sp*

5. *Minervarya asmati*

6. *Minervarya pierrei*

7. *Feihyla sp*

8. *Raorchestes sp*

9. *Polypedates leucomystax*

10. *Polypedates teraiensis*

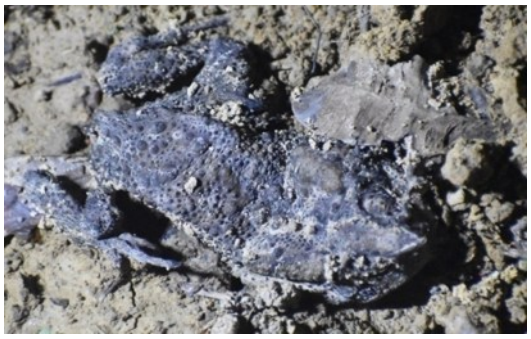
11. *Humerana humeralis*

12. *Hylarana leptoglossa*

13. *Hylarana tytleri*

14. *Microhyla mymensinghensis*

15. Male *D. melanostictus* calling



16. Road-kill carcass of *D. melanostictus*

Image 1 to 16 showing the recorded anurans and road kill carcass documented in the study site.

A total of 3352 anuran individuals of 14 species were recorded in five different microhabitat (Fig 2). The comparison of anuran diversity indices in various microhabitats is shown in Fig 3. The dominance index shows that topsoil (0.257) were highly dominated microhabitats followed by Tea Garden (0.225), wetland (0.210), Understory (0.187) and human habitation (0.184). The decreasing order of Shannon diversity indices (H′) were Understory (1.98)> Human habitations (1.86)> Wetlands (1.79)> Tea gardens (1.65)>Topsoil (1.47). Understory (1.71) contributed the most species-rich microhabitat followed by Wetlands (1.11), Human habitation (1.10), Wetlands (1.24 and Topsoil (0.62). Evenness or equitability index shows that Topsoil were most even (0.917) followed by Human habitation (0.897), Tea gardens (0.85), Wetlands (0.81) and Understory (0.8). The anuran diversity in the study area appears to be closely linked to factors such as canopy cover, understory vegetation, swampy environments, and the presence of artificial habitats like tea gardens and human settlements.

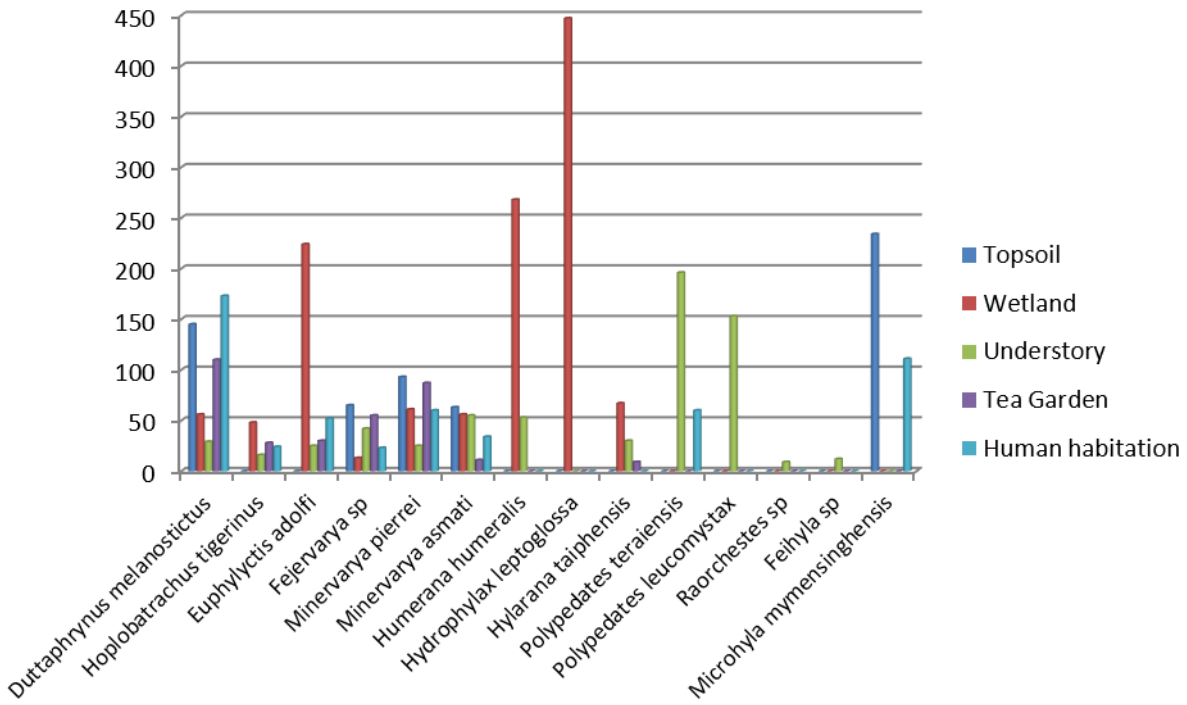


Figure 2. Total number of anuran individuals of 14 species distributed in different microhabitat

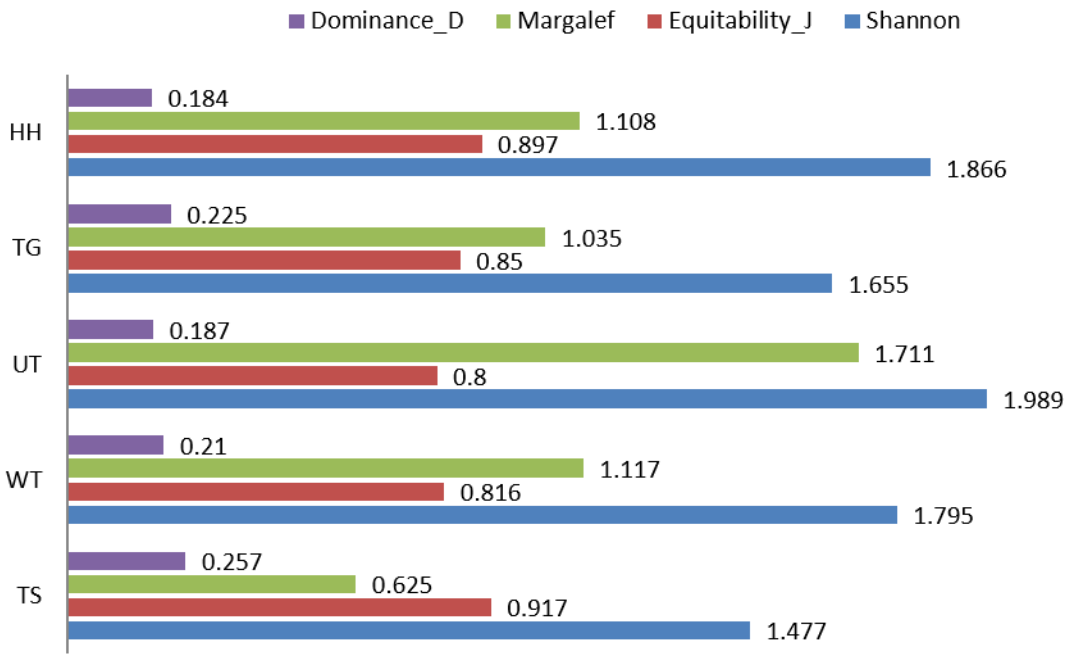


Figure 3. Comparing the Diversity Indices of Anurans in various microhabitats at Gibbon Wildlife Sanctuary (TS- Topsoil, WT- Wetlands, UT- Understory, TG- Tea Gardens, HH- Human Habitation.

Three species (Fejervray sp-Image 4, Feihyla sp- Image 7 and Raorchestes sp- Image 8) were identified up to genus level due to cryptic species complex. The frequently encountered species *Duttaphrynus melanostictus* (Image 1), demonstrated a preference for terrestrial habitats, including grasslands, sometimes observed under shrubs, tea estates characterized by dry and damp moisture conditions and human habitation. Also, we observed calling of *D. melanostictus* at evening (Image 15) in temporary pools near human habitation. *M. asmati* (Image 5) was encountered near temporary water bodies and aquatic habitats (Howlader, 2011; Decemson *et al.,* 2021; Saikia and Sinha, 2023) with decent amount of leaf litters , in swamps and marshes near to temporary pools, and also sometimes near to human habitation living in the vicinity of Gibbon Wildlife Sanctuary. *Fejervarya sp* (Image 4) was observed in grassy wetlands near to human habitation as well as in saturated lands near to tea gardens, and potholes within the sanctuary. Species like *Microhyla mymensinghensis* (Image 14) was

observed near to human habitation with moderate leaf litter and in surrounding land with high moisture content, *Hylarana leptoglossa* (Image 12) was found exclusively in swamps and marshes (Ahmed *et al.,* 2009) where ample water was present for breeding. *Raorchestes sp* (Image 8) was observed only in bamboos about 1.4 m from the ground level. *Feihyla sp* (Image 7) was recorded perching on tree leaves at an elevation of approximately 3 meters above ground level. Thus, some species are capable of thriving in various microhabitats, while others are restricted to specific types of microhabitats.

Conservation threats

During the survey, the sanctuary was found to be fragmented mostly by tea estates, small-scale agriculture, human settlements, and illegal logging activities conducted by local villagers (Sarkar & Devi, 2014; Chakraborty & Gupta, 2005; Chetry *et al.,* 2022). Around 2-4 amphibian species mostly *D. melanostictus* were road killed (Image 16) due to vehicular movement (mostly 2 wheelers) between Madhupur Camp and Kotahlguri camp. Apart from consuming *Hoplobatrachus tigerinus,* the species *Polypedates teraiensis* which upon contact with human body secretes mucus as a form of defense mechanism was attributed to the misconception that the species inflicts bites on human body resulting into killing of the species by the people residing in proximity to GWS. The fragmentation of green canopy coverage, compounded by the presence of upcoming electrified railway track aggravates the conservation status of anuran fauna in the area.

We provide the first time record of *Minervarya asmati* (morphologically) from Assam with proper photographic analysis. Decemson *et al.,* 2021, confirmed genetically only from Assam. This underscores the importance of further research on anuran habitat and diversity within the Gibbon Wildlife Sanctuary. Such studies are essential for advancing our understanding of anuran ecology and contributing to broader amphibian research in the region.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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