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AN ACCOUNT OF AMPHIBIAN DIVERSITY AND COMPOSITION IN THREE DIFFERENT HABITAT TYPES IN BAKSA DISTRICT, ASSAM, INDIA

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AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration between both authors. Author ARB designed the experiment. Author ARB designed the experiment. Authors AA and ARB did the analysis. Author AA wrote the manuscript. Both authors read and approved the final manuscript.

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ABSTRACT

Amphibian assemblages in three different habitat types, rice field; built up habitat and marshland were studied in the Baksa district of Assam, India. Visual encounter survey, opportunistic search and active search methods were used to record amphibians encountered. A total of 1410 individual amphibians were recorded that included 16 species belonging to 11 genera and five families. Among the three habitat types, built up habitat showed maximum species diversity followed by marshland and rice-field. It could be predicted that habitat heterogeneity and architectural complexity are the best predictors of amphibian diversity in the study area. The possible reasons correlating the composition have been discussed. This study indicates the importance of habitat as a resource in the conservation of amphibian species. Further, this happens to be the first report on amphibian assemblage from Baksa district, Assam, India.

Keywords: Amphibia; Baksa; built up habitat; rice field; marshland; species diversity; conservation.

1. INTRODUCTION

India is one of the 17 mega diverse countries of the world [1]. It houses three of the world's eight biological hotspots [2] and possess 10% of world's total recorded species. High biological diversity of the country is mostly contributed by the Western Ghats and the North East India. Assam, one of the states of NE India is a constituent of the Eastern Himalayan Biodiversity Region. The plains of the state belong to either Brahmaputra valley or Barak valley. Western Assam is a part of the Brahmaputra valley and is surrounded by hills of lower Himalaya in the north and hills of the Meghalaya plateau in the south. It

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includes the districts of Goalpara, Kokrajhar, Bongaigaon, Barpeta, Dhubri, Chirang, Baksa, Nalbari, Kamrup Metro and Kamrup Rural [3]. The plethora of biodiversity in this region is often attributed to its unique geomorphic environment represented by the flood plains, hills of South Indian plateau system [4]. The geomorphology, soil quality, topography, temperature and rainfall pattern together take care of the vital needs for the survival & reproduction of a species, by coupling their physical adaptability to these factors. The habitat heterogeneity, altitudinal variation and architectural complexity of Assam compound the species diversity rate.

Amphibians are an important class of vertebrates vital for ecosystem functioning. Assam is the house to 67 species of amphibians [5]. Yet, the amphibian fauna of Assam remains poorly studied [6]. Little information about its assemblage is available. The past years have been witness to loss of biodiversity. Habitat loss, overexploitation, fungal disease and road mortality are regarded as key threat to amphibian diversity and abundance globally [7]. However, information on such aspect in Assam is scanty making conservation priorities difficult.

2. MATERIALS AND METHODS

2.1 Study Site

Study of amphibian diversity was carried out in three different habitats in the Baksa district of Assam. Baksa district shares its boundary in the south with Kamrup, Nalbari and Barpeta districts and in the north with Bhutan. Chirang and Udalguri districts lie to its west and east, respectively. The district displays a variety of habitats including flood plains, grasslands and hilly terrain.

For the study, three types of habitats were chosen; each unique in its vegetation and resource composition. Field sites were identified at three towns namely, Salbari (approx. 26°39′14″N; 91°05′16″E), Tamulpur (approx.26°37′15″N; 91°34′08″E) and Goreswar (approx.26°31′55″N, 91°43′17″E). For each habitat type, three sample sites in each of the towns were chosen.

2.1.1 Rice Field

The rice field habitat is characterised by rice as the vegetation cultivation of the land. Small demarcating lanes passing through the field (locally known as “aali”) were considered. The fields had water logging.

2.1.2 Built up Habitat

This habitat encompasses areas in the vicinity of human settlements. This type of habitat is characterised by a variety of trees, shrubs, creepers, herbs and bamboo trees. Ponds and small water bodies around the houses were also considered. Overall, this habitat type portrays disturbed habitats represented by roads, household infrastructure, fencing, water bodies and high human activities.

2.1.3 Marshland

This type of habitat is represented by water bodies dominated by water hyacinth. Reeds found in and around such water bodies were also considered. Shrubs and woodlands around the water bodies were excluded**.**

2.2 Sampling Methods

The survey was conducted at different times of a 24 hr clock and in the months of April to October 2018. Visual encounter survey, active microhabitat search, survey at breeding sites, road cruising, and opportunistic records were employed to study the amphibian diversity. Further, active search was also carried out that involved looking around rocks, logs, leaf litters and burrows. Data on species, stage of growth of the individual and number of individuals were recorded in each observation. All species encountered and their habitats were photographed using a Canon SX 40 HS camera.

2.3 Identification

The identification of samples collected into species were made by referring to the taxonomic keys of Chanda (1990, 1994, 2002) [8, 9], Smith (1935, 1943) [10, 11], Dutta (1997) [12] and Schleich and Kastle (2002) [13].

2.4 Data Analysis

Amphibian diversity in the study habitats was assessed. Shannon-Weiner Diversity Index (H’) was employed to measure species richness and abundance.

$$H' = - \Sigma\, p_i \ln p_i$$

P_i refers to the number of individuals of species ‘i’ divided by total number of individuals of all species; ln is the natural logarithm.

Simpson’s index (D) was used as a measure of species dominance. Simpson’s index is calculated as follows:

D= $\frac{\Sigma i\, n\, (ni-1)}{N(N-1)}$

Simpson's Diversity Index is then calculated as 1-D.

In this, *ni* refers to the number of individuals of a particular species; *N* refers to the total number of individuals of all the species.

Margalef's diversity index (D_{mg}) was also calculated to determine the species richness. D_{Mg} is calculated as:

$$Dmg = \frac{S-1}{\ln N}$$

In this, *S* represents the total number of species and *N* is the total number of individuals of all species.
Evenness was measured in terms of Shannon Evenness Index (E) by using the formula:

$$E = -\frac{\Sigma i \left(\frac{ni}{N}.ln(\frac{ni}{N})\right)}{\ln N}$$

Graphical representation of relative species abundance, evenness and richness was done using rank abundance curve or Whittaker plot.

3. RESULTS

3.1 Amphibian Composition

A total of 1410 amphibian sightings were recorded in three habitat types of Baksa district. The amphibians encountered belonged to16 species of 11 genera under 5 families (Table 1). The five families include *Bufonidae*, *Rhacophoridae*, *Dicroglossidae*, *Ranidae* and *Microhylidae*. Of the three habitats studied, highest amphibian sighting was recorded in built up habitat followed by marshland and least sightings were recorded in rice field.

The family with most abundant species was found to be Dicroglossidae with six species amongst all the three habitats. In the built-up habitat, total of 624 amphibians belonging to 15 species were observed. The most frequently recorded species in this habitat was *Euphlyctis cyanophlyctis*, followed by *Microhyla ornata* and *Feihyla vittatus*. Two species namely, *Duttaphrynus melanostictus* and *M. ornata* were exclusively found in the built up habitats. In the marshland, 12 species were observed. *Hylarana tytleri* was the most frequently observed species. *F. vittatus*, *Hoplobatrachus tigerinus* and *E. cyanophlyctis* were also frequently observed in this type of habitat. The area where least number of species and amphibian individuals were recorded is the rice field. *E. cyanophlyctis* was the most abundant species recorded in the habitat followed by *Fejervarya teraiensis* and *H. tigerinus.* Five of the species were common to all the three habitat types. These include *H. tigerinus, H. crassus, F. teraiensis, Fejervarya* sp *and E. cyanophlyctis.*

3.2 Diversity Indices Analysis

The species diversity of the three habitats was calculated using Shannon-Weiner and Simpson's index (Table 2). The highest species diversity was recorded for built up habitat and Shannon- Weiner index and Simpson's index was found to be 2.498 and 0.911, respectively. The evenness index was recorded as 0.388 and Margalef's Index was found to be 2.175. Among the three habitat types studied, built up habitat shows the highest diversity of amphibian fauna. Marshland shows lesser species diversity than built up habitat but higher species diversity than rice field. Rank abundance curves for each habitat were generated (Fig 2, Fig 3 and Fig 4).

Table 1. Account of Amphibian species encountered in the three habitat types

Family	Bufonidae	Dicroglossidae	Ranidae	Microhylidae	Rhacophoridae
Species	*Duttaphrynus melanostictictus*	*Hoplobatrachus crassus*	*Humerana humeralis*	*Microhyla ornata*	*Feihyla vittatus*
		Hoplobatrachus tigerinus	*Hylarana tytleri*	*Uperodon globulosus*	*Polypedates leucomystax*
		Fejervarya pierrei	*Hylarana taipehensis*	*Microhyla butleri*	
		Euphlyctis cyanophlyctis	*Hydrophylax leptoglossa*		
		Fejervarya sp.			
		Fejervarya teraiensis			

Table 2. Amphibian species recorded in the respective habitat sites

Species	Common Name	Rice Field	Built up habitat	Marshland
Duttaphrynus melanostictus	Asian common toad	-	+	-
Hylarana taipehensis	Taipei grass frog	-	+	+
Feihyla vittatus	Striped Asian tree frog	-	+	+
Hoplobatrachus tigerinus	Indian bull frog	+	+	+
Hoplobatrachus crassus	Jerdon's bull frog	+	+	+
Fejervarya pierrei	Pierre's wart frog	+	+	-
Fejervarya teraiensis	Terai wart frog	+	+	+
Fejervarya sp		+	+	+
Hydrophylax leptoglossa	Assam Common Frog	-	+	+
Hylarana tytleri	Yellow-striped Frog	-	+	+
Microhyla ornata	Ornamented pygmy frog	-	+	-
Humerana humeralis	Bhamo frog	-	+	+
Uperodon globulosus	Indian balloon frog	-	Rare	-
Polypedates leucomystax	Common tree frog	-	+	+
Microhyla butleri	Butler's narrow mouthed toad	-	-	+
Euphlyctis cyanophlyctis	Indian skipper frog	+	+	+
Total no. of individuals recorded		**369**	**624**	**417**
Total no. of species recorded		**6**	**15**	**12**
Shannon-Weiner Diversity Index		**1.734**	**2.498**	**1.898**
Simpson's Index of Diversity		**0.816**	**0.911**	**0.842**
Margalef's Diversity Index		**1.015**	**2.175**	**1.491**
Evenness Index		**0.279**	**0.388**	**0.315**

[+ represents presence and – represents absence of a species]

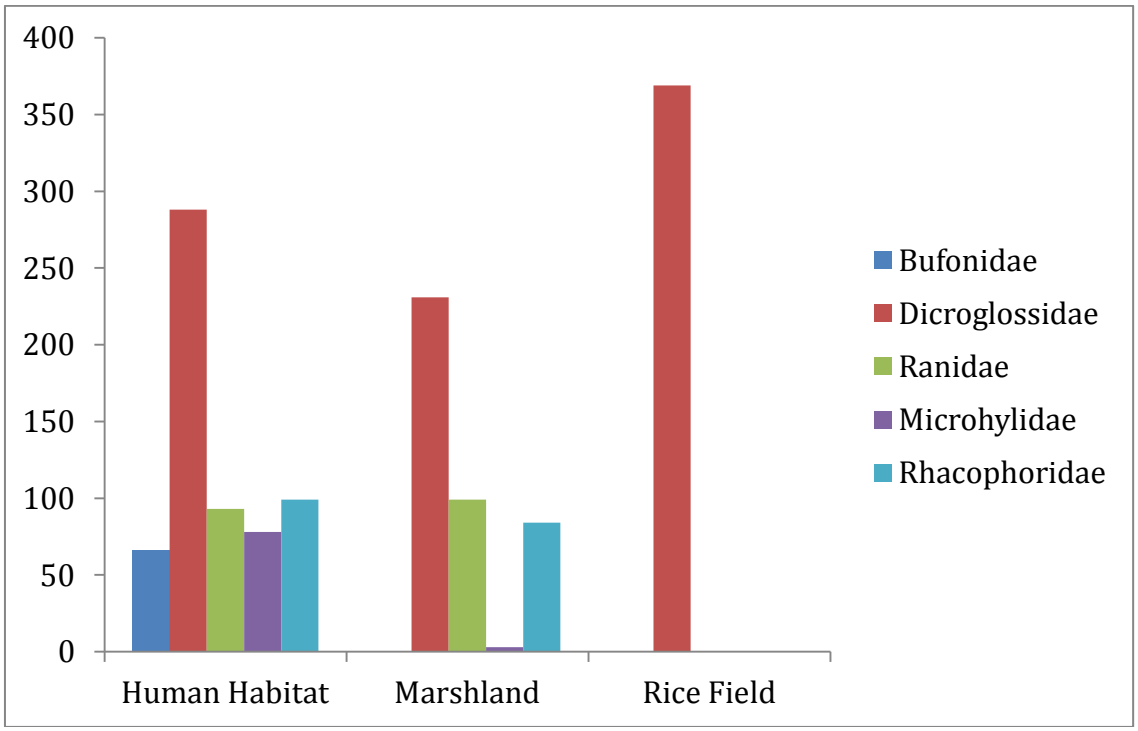

Fig. 1. Graphical representation of number of species belonging to different amphibian families in the three habitats studied [Y axis represents the number of individuals]

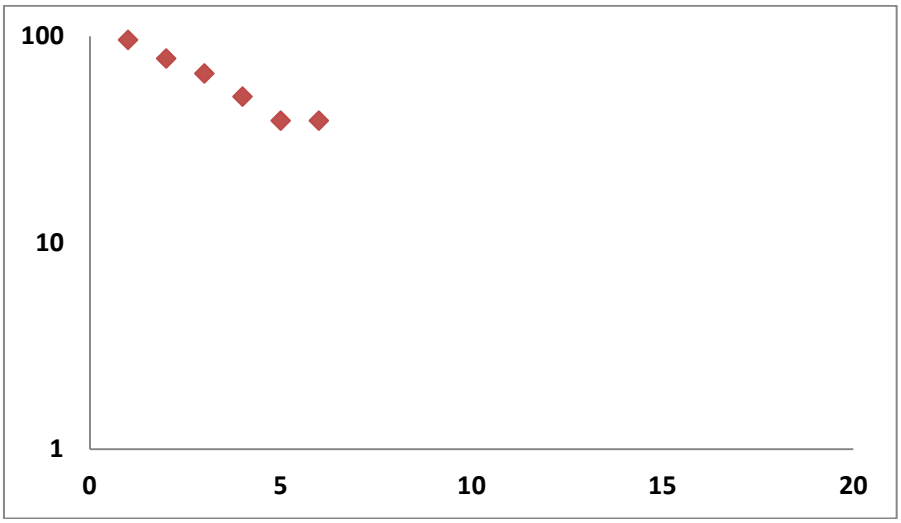

Fig. 2. Rank abundance curve of amphibian species in rice field habitat

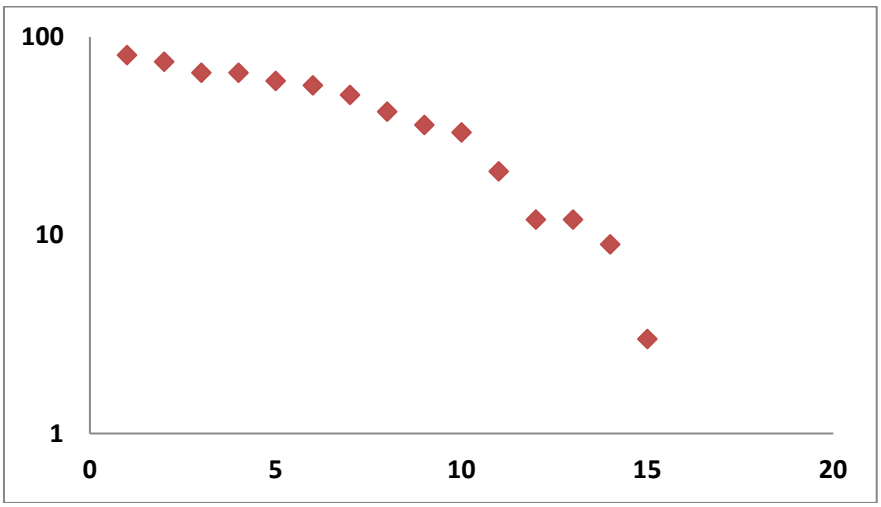

Fig. 3. Rank abundance curve of amphibian species in human habitat

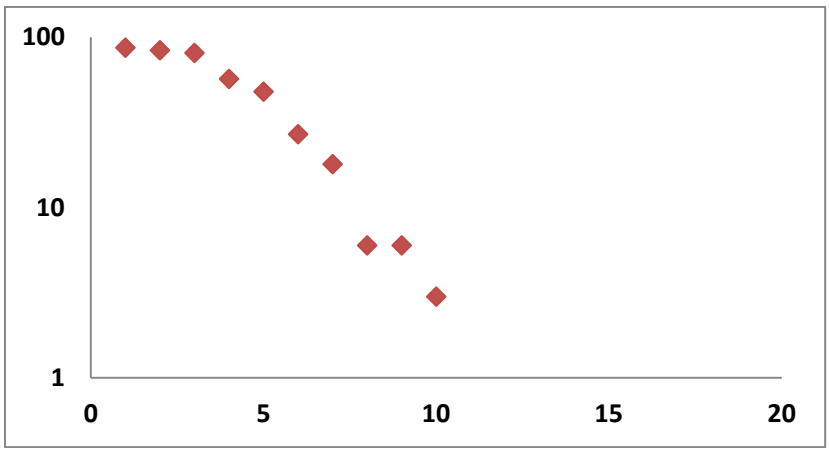

Fig. 4. Rank abundance curve of amphibian species in marshland habitat

4. DISCUSSION

Our study is an attempt to study the amphibian diversity in Baksa district of Assam, India. A total of 1410 amphibian individuals were recorded from all the localities of the three study habitats, namely rice field, built up habitat and marshland. The results of our study reveal that built up habitat has highest species diversity of amphibians followed by marshland and least amphibian diversity is displayed in rice-field habitat. Shannon Weiner Index and Simpson's Index for built up habitat are 2.498 and 0.911, respectively. Marshland and rice field shows Shannon-Weiner Index values of 1.93 and 1.70, respectively; and Margalef's Index of 2.175. Built up habitat shows highest abundance of amphibians (624) compared to other habitats. Though the indices do not generate an absolute value; however they give a good image of species diversity. The two indices were used as they take into account both species richness and abundance of the species [14]. Further, the evenness indices for rice field, human habitat and marshland are 0.388 and 0.315, respectively. For a community, if the value for evenness approaches zero, it is said to have evenly distributed individuals for each species. However, if the value approaches one, the community is said to have less evenly distributed individuals. In our study, the individuals can be considered to be evenly distributed in each habitat.

Built up habitat has been represented by areas nearby human settlements that include human activity and infrastructure. Vegetation type in this habitat includes variety of trees such as *Mangifera indica* (mango), *Shorea robusta (Sal), Albizia procera* (*Koroi*), *Bombax ceiba (Semal), Emblica officinalis (Amla)*; shrubs and herbs such as *Murraya koenigii (*curry leaves*), Holarrhena antidysenterca (Kutaja), Dendrocalamus hamiltonii (*Tama bamboo*), Calamus tenuis (Jati-bet).* Creepers like *Acacia pennata (*rusty mimosa*), Millettia auriculata (agarbel), Paederia foetida (*Chinese flower*), Entada phaseoloides* etc were also present. Human houses as well as ponds and bamboo trees around the houses and roads were taken into consideration in this habitat type. In totality, built up habitat displays high architectural complexity. The habitat heterogeneity might provide important food resources and niches to support high amphibian diversity. 16 different amphibian species were observed in all the three habitats; of these, built up habitat houses 15 species. The most abundant species in this type of habitat is *Euphlyctis cyanophlyctis.* It belongs to the family Dicroglossidae and adults are usually found basking at the edge of water bodies and are common [15]. *E. cyanophlyctis* is considered as a weed frog species in Asia and is mostly reported from water bodies [16]. *Duttaphrynus melanostictus* and *Mircohyla ornata* were exclusively seen in built up habitats. Our results are in accordance with the fact that the former species remain associated with human habitations and the later is often found in leaf litter [17]. Further, *D. melanostictus* is known to feed on insects that are common pests and are often associated with human dominated areas [18].

Marshland habitat showed second highest amphibian diversity. The dominant vegetation here was *Eichhornia crassipes* (water hyacinth). Frequently observed species was *Hylarana tytleri* followed by *Feihyla vittatus. H. tytleri (*Theobald, 1868) has been reported in various aquatic habitats and in swampy areas [19] and is known to use stagnant water bodies for breeding [20]. Our study is in accordance to the findings by Roy et al. (2018) where they recorded individuals of the species calling from water bodies with water hyacinth. Also, similar to our study, Deuti and Goswami (1995) has reported the species in ponds with floating plants [21]. Rice field habitat shows the least species diversity. Only 6 species, namely, *Euphyctis cyanophlyctis*, have been recorded from the study site. In the present study *E. cyanophylctis* has been reported to be the most abundant species in the rice fields and it is often associated with paddy fields [22]. Other species recorded in this habitat type include *Fejarvarya teraiensis, Hoplobatracus tigerinus, F. pierrei* and *H. crassus* and an unknown species of *Fejervarya.* Similar results were obtained by Roy et al. (2018) in the Dibang river basin, Arunachal Pradesh [23]. In our study, all the individuals sighted in rice fields belong to the family Dicroglossidae. Species of genera *Hoplobatrachus* and *Fejervary*a are mostly aquatic [24]. Rice fields serve as transient wetlands [25] and thus provide foraging and breeding grounds for amphibian species. Rice field represents monoculture vegetation and thus might have contributed to low amphibian diversity as compared to the other habitat types. Low diversity might also be attributed to the use of pesticides and insecticides in the fields [26].

Our study provides information about the amphibian species diversity in different habitat types in the Baksa district of Assam, India. No data on the amphibian diversity of the district is currently available. The study, therefore, provides a significant snapshot of the amphibian diversity and is a preliminary comparative account to study the amphibian species abundance and richness in three different habitat types (rice fields, built up habitats and marshland) of the district. The differences in the species diversity might be attributed to the variation in vegetation types and niche availability [27, 28]. Physical barriers like roads might prevent the movement of amphibian individuals from one habitat

to another [29, 30]. This might cause certain individuals to remain confined in a particular region. Habitat complexity and heterogeneity is therefore vital in biodiversity. This study can further provide a platform to facilitate conservation and management of amphibian species and habitats. However, further research work involving long term sampling is essential to understand various factors implying the area's amphibian diversity.

5. CONCLUSION

Though Assam is rich in amphibian fauna yet not much information about its assemblage is available. Our study is an attempt to evaluate the amphibian diversity in three different habitat types in the Baksa district of Assam and to evaluate the possible reasons correlating diversity. To the best of our knowledge this study provides data on the amphibian diversity of Baksa district for the first time. We predict that habitat heterogeneity and architectural complexity are the best predictors of amphibian diversity in the study area. This study thus indicates the importance of habitat as resource in the conservation of amphibian species. It can further provide a platform to facilitate conservation and management of amphibian species and habitats.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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