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An assessment about habitat preference and diversity of amphibian fauna (Anurans) in Aurangabad Bihar India

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Abstract
Present study of the Amphibian diversity mainly of Anuran amphibian and their habitat preference was conducted for one year between March 2017 to February 2018 at Aurangabad, an important district of Bihar, India. Nine species of Anuran amphibian belonging to four families and eight genera were found to occur in Aurangabad Bihar. The habitat preference of these amphibians are of wide range like in and around the natural and artificial water bodies, human residential area, forested areas, termite nest, tree hole, under spaces of logs, leaf litter and so on. Of the nine Anuran amphibian identified 5 species were found in and around the Deo Suryakund (site-I), all the 9 species were found and identified in and around the area of Raja Jagganath dam Deo (site-II), and 7 species were identified in and around the Umga pond (site-III) of Aurangabad Bihar. Analysis of the collected data on the anuran community of the study area revealed Shannon–Wiener species diversity index minimum (1. 213) at site-I and maximum (1.969) at site-II. In contrast Margalef richness index value was minimum (0.693) at site-I and maximum (1.325) at site-II. This study showing the amphibian diversity of Aurangabad and their habitat preference.

Keywords: amphibian diversity, Aurangabad Bihar, diversity index, habitat preference, margalef richness index

1. Introduction
Amphibians are the diverse group of organisms having dual mode of life i.e aquatic as well as terrestrial. The species in these groups includefrogs, toads salamanders and newts. thei. e aquatic as well as terrestrial. The species in these groups includefrogs, toads salamanders and newts. They inhabit a wide variety of habitats with most species living within terrestrial, fossorial, arboreal or freshwater aquatic ecosystems. Anura is a diverse Order under the Class Amphibia that contains 406 described species known from India (Dinesh *et al*. 2020) [7]. Out of these Bihar state is the home of 14 amphibian species belonging to 4 families and 8 genera (Sarkar *et al*. 2004) [25]. It is very essential to know about the habitat preference and habitat use of different species is a major work and requirement in conservation biology (Hartel *et al*. 2006) [12]. The habitats, distribution, abundance and ecology of various rare larger wild animals have been reported while working on their conservation strategies; however, such information is very few in case of amphibians as we hardly know the role of quality and quantity of habitat in determining distribution and abundance of anurans (Krishnamurthy 2003) [14]. For implementation the specific conservation programmes for amphibians it is important to understand the factors that control their diversity in that particular region (Vasudevan *et al*. 2001) [29]. As amphibians inhabit, both in terrestrial and aquatic habitation, a change in either or both the ecosystems can lead to adverse effect on amphibian diversity of any particular area (Dahanukar and Padhye 2005) [3]. The present work was done in and around major water bodies of Aurangabad city of Bihar state to assess the Amphibian diversity (anuran) as these pretty creatures are easily victimizedand greatly affected to the alteration in environmental components as environmental pollution and habitat degradation. I have surveyed and sampled the amphibian species pollution free areas however there were some anthropogenic activities adversely affect the amphibian diversity. Anurans are also considered very important as ecological and economic standpoints of view. As they are good ecological indicator indicator and they also acts efficiently as natural agent to control different varieties of pests i.e good biological controller also. In Aurangabad District of Bihar mainly anuran amphibians are found that are represented by 9 species belonging to 4 families and 7 genera that show patchy and discontinuous distribution in this area. Amphibians found in Aurangabad were represented by only the order Anura. Boulenger G A (1890) [2] described amphibian fauna of British India. Venkateshwarlu & Murthy (1972) first of all described, the amphibian species of Bihar state, with very few description and short notes on their character and habitat also. Later on Sarkar A.K (1991) [26] described the amphibian species of Chhotanagpur (Jharkhand) it only provides taxonomical description of amphibians. Sarkar A.K *et al*. (2004) [25] provide list of amphibians in the state fauna series of ZSI and provide taxonomical description of 14 species of amphibians from Bihar. But till date no any workers provide the comprehensive account of amphibian diversity of Aurangabad dist.Bihar. Major effective surveys were conducted in Western Ghat regions, abode of most diverse species of amphibians and these were under taken by Abraham *et al*. (2001) [1], Dahanukar and Padhye (2005) [3], Krishnamurthy (2003) [14] and Purushotham *et al*. (2011) [21]. Similar important works from the North-East India were reported by Meren *et al*. (2003) [15] and Ningombam and Bordolol (2007) [18]. These works have amply documented the diversity and microhabitats of amphibian species. Several authors also work on amphibian diversity in other parts of India such as Hegde and Roy (2011) [13], Padhye and Ghate (2002) [19] and Padhye *et al*. (2002) [20], Srinivasulu *et*

al. (2007) [28]. The main objective of the present study was to estimate the amphibian diversity and their habitat preference in altered ecosystems due to various anthropocentric activities, a work first of its kind, in Aurangabad district of Bihar province. As species diversity indices have been used to characterize communities and ecosystems (DeJong 1975) [6], alpha diversity measures are used to comment on the within-habitat or intra-community anuran diversity of the study areas.

2. Study Area

The study area (Figure 1-3) of present study is the Aurangabad district of Bihar province. Aurangabad district located between 24° 45' to 240 75' N and 84° 22' to 84° 37' E, and is the main southern district of Bihar, India. The total area of Aurangabad is 1419 sq km and the elevation varies between 100 and 108 m. Vegetation of the study area is mainly of dry deciduous type dominated by Shorea robusta. The river Sone, Punpun, Batane, and a large number of temporary and permanent lentic water bodies and wetlands are present in the study area, that are the main habitat for large number of amphibian species. Forest, Grasslands and Cultivated land is situated around the study sites. We carried out the present study between March 17 February 18 which included a consecutive pre-monsoon, monsoon and post-monsoon periods. We selected three study sites from the perspective of contrasting habitat characteristics that differ in amphibian species and their habitat preference also. Site-I, Deo Suryakund (24.7033^0 N and 84.3542^0 E) was a large permanent artificial water body occupying 821.5 m^2 area with a mean depth of 2 m. Both floating and submerged aquatic weeds were noted in this pond.Because of Hindu rituals on the bank of this pond, this become very important for amphibian species. This pond was in the vivinity of dense human habitation besides this pond, few small temporary water bodies, agricultural field around this Suryakund were also included for tha sampling and identification of amphibian species of this area. Raja Jagganath dam (24.5676^0 N and 84.4549^0 E) was selected as site-II. This site or study is very rich in amphibian diversity was large forested area that is surrounded by thick matty grasslands provide suitable habitat for various species of amphibians and all the 9 species of amphibian recorded from here. It has dense forest and grassland extending about 20 sq km was with about 20 permanrent and temporary water bodies. Umga pond Madanpur (24.6391^0 N and 84.5596^0 E), covering an area of about 5-7 acre eith catchment area about 40 acre. This pond is surrounded by mountaneous region and cultivation land. It was a low lying area and in the monsoon, most of the area of this study site was inundated by temporary water and watery area become large during monsoon season.

3. Materials and Methods

During the whoe survey and sampling we have used visual encounter survey (VES) and acoustic encounter survy (AES) for the rapid assessments and the evaluation of larger areas (Ro del and Ernst 2004) [23]. The visual encounter survey (VES) was the most frequently used technique throughout the study and was used in all the terrestrial sites studied and sampled. We laid stress primarily to estimate the varied types of suitable habitats, where the anuran amphibian species mainly thrives. We also implemented different active searches like turning rocks and logs, peeling bark, digging through leaf litter, and excavating burrows and termite mounds in order to got a good and reliable result. We also occasionally performed acoustic searching along the wooded trail, degraded forest edges and along water bodies where visual encounter was not possible. We conducted the study between 07:00 am to 10:00 am and 06:00 pm to midnight. Flashlights were also used to locate the anuran species in night. The anuran diversity was also studied by noting the deposited eggs during breeding period. Nesting site, type of nest and egg cluster was helpful in identifying anuran species. The field data for each individual encountered like locality, date, time, weather condition, habitat, microhabitat and reproductive condition of each individual (if it could be determined), co-existing species (if any) and other behavioral notes were recorded. Taxonomic notes of individuals captured during field work and morphometric data were also noted. We calculated Shannon–Wiener diversity index, Pielou's evenness index, Margalef's richness index and Simposon's dominance index using D index software version 4.0. Photographs of the representative species and their habitats were taken with a digital camera. Geographic position of study sites were recorded by using a GPS mobile software. Coordinates were recorded as latitude and longitude in degrees. Identification of the amphibian species was done using the identification keys available as Dutta (1997) [5], Inger and Stuebing (2005), Daniels (2005) [4] and Frost (2018) [10].

Fig 1: Deo Suryakund, An artificial pond of Aurangabad Bihar (SITE -1)

Fig 2: Raja Jagganath Dam deo Aurangabad Bihar (SITE 2)

Fig 3: Umga pond Madanpur Aurangabad Bihar (SITE 3)

4. Results and Discussion

A total of nine anuran belonging to 4 families and 7 genera species were recorded from all the study sites of Aurangabad Bihar India (Figure-4). Many species of

anurans are found to spend a good part of their life hiding, either in water under detritus, or on land under leaf litter, rocks or logs and even underground holes and termite mounds (Ray 1999) [16]. Therefore with the increasing in microhabitats and breeding sites of amphibians the diversity of anuran species increases.

However, the amphibian diversity of Aurangabad Bihar region is not so high. During the survey we found only nine species of amphibians under four families named, Bufonidae, Dicroglossidae, Microhylidae and Rhacophoridae. The amphibian species were represented by Duttafreanus melanostictus, Duttaphrynus stomaticus, Hoplobatrachus tigerinus, Hoplobatrachus crassus, Sphaerotheca braviceps, Euphlyctis cyanophlyctis, Fejervarya limnocharis, Microhyla ornate and Polypedates maculatus (Table -1).

Fig 4: Different amphibian (Anuran) species found in Aurangabad, Bihar India

Table 1: Amphibian species found in Aurangabad Bihar India with their habitat, occurance, abundance and IUCN status

Species	Common name	Family	Habitat preference	Occurance in study sites	Abundance at study sites	IUCN status
Duttaphrynus melnostictus (Schneider, 1799)	Common Asian toad	Bufonidae	Dry and wet terrestrial areas, Human habitation, Forest, Road side	II, III	C	LC
Duttaphrynus stomaticus (Lutken, 1864)	Marbled toad	Bufonidae	Terrestrial areas, human habitation, leaf litter, wooden log	I, II III	VC	LC
Hoplobatrachus tigerinus (Daudin, 1803)	Indian bullfrog	Dicroglossidae	Water bodies, ditch, drain, pool	I, II, III	VC	LC
Hoplobatrachus crassus (Hoffman, 1932)	Jerdon's bullfrog	Dicroglossidae	Water bodies, pool, mud	I, II, III	C	LC
Sphaerotheca braviceps (Schneider, 1799)	Indian burrowing frog	Dicroglossidae		II, III	O	LC
Frejerverya limnocharis (Gravenhorst,1829)	Asias grass frog	Dicroglossidae	Water bodies, Forest, Agricultural field	II	O	LC
Euphlyctis cyanophlyctis (Schneider, 1799)	Skittering frog	Dicroglossidae	Water bodies	I, II, III	VC	LC
Microhyla ornata (Dumeril & Bibron, 1849)	Ornate narrow mouthed frog	Microhylidae	Under stone, near water bodies, temporal water	II,	O	LC
Polypedates maculatus (J.EGray,1830)	Common tree frog	Rhacophoridae	Human habitation, tree hole, forest, termite nest	I, III	VC	LC

The most common species is Duttaphrynus stomaticus that was mainly observed to be ground living, occupying both dry and damp moist terrestrial habitats including dump-yards, under the leaf litter, wood log and near about human habitations. This species observed in large number during the dawn and night period this was observed to be the most common 'road kill' anurans in study locations throughout the year. The life-cycle of D. melanostictus is biphasic type as they were observed to breed in monsoons (early July to early October) and also in vernal season (end of January to end of March). Indian Bullfrog (H. tigerinus) was frequently found in rainy season in and around lentic water bodies, paddy field areas, and occasionally also at residential areas. These species were also observed throughout the year near the human habitation in the pool, Ditch and drains. We observed that in the rainy season when this species was commonly available, people collected live species of this variety as a full-grown frog and sold in the market (NE

states)for the delicacy of its legs. Jerdon's Bull Frog (H. crassus) was morphologically much similar to the Indian Bullfrog. The legs of Jerdon's Bull Frog were also used as a delicacy. Both these bull frogs were observed to be good long distance jumpers. Sphaerotheca braviceps (Indian burrowing frog) also observed frequently in Aurangabad district. They found mainly around the temporary water bodies burrowed inside the holes in soil, leaf litter and logs. The skipper frog (E. cyanophlyctis) was very much common in both lotic and lentic water bodies of Aurangabad Bihar. The life-cycle of E. cyanophlyctis was also biphasic and followed the similar pattern as stated for D. melanostictus.We found millions of tadpoles of skipper frog in the month of January–March in nearby water bodies. Paddy Field Frog (F. limnocharis) was also a common species in and around Aurangabad. It was located mainly in the temporal lentic waterbodies, agricultural land, degraded forest and beside the wet banks of water bodies. Common Indian Tree Frog (P. maculatus) was also a very common species found in tree hole, stem of banana tree, damp or moist area of domestic places including bathrooms and inside the well and hand pumps. However, in the breeding time they were frequently found in and around lentic water bodies, preferably in the temporary rain water pools and puddles. This species of Common Indian tree frog can easily observed in the home of Aurangabad. They were observed to prepare a foam nest which remained suspended in the vegetation above the water level. Like most of the rhacophorids, they deposit their eggs in the foam nest attached to vegetation either above or near water (Mohanty-Hejmadi and Dutta 1988), Ornate Narrow- Mouth Frog (M. ornate) was encountered only in the breeding period (Monsoon season) in temporary lentic waters. This is the smallest frog (30–35 mm) found in Aurangabad. The call of this species was very loud and the frequency of its call was also very high. Das *et al*. (2009) [5] reported that the chorus of this species was commonly heard in and around human habitation, as well as along forest edges and in plantations. Throughout the study F limnocharis and Microhyla ornata was not found in the site-I and site-III but in site-II (Table 1). This may be due to the absence of proper hilly areas and preferred forest in sites I and III. Likewise, absence of Duttaphrynus melanostictus, Sphaerotheca braviceps, Frejerverya limnocharis and Microhyla ornate indicating the lack of habitat for these species in these areas site-I (Table 1) and may be accounted from the fact of absence of any suitable water body in the site concerned. Between Februarys to April a good number of tadpoles of E. cyanophlyctis and D. stomaticus were seen to occupy the site-II and III. This moist site with a large lentic water-body having several small streams was observed to be least disturbed and hence was a good habitat of anuran species. Study site-I had no additional water bodies attached to main pond, so the anuran species were found to migrate towards the nearby agricultural field during their mating season. Species diversity (E Mayr) is one of the fundamental concepts of ecology that has been used to characterize communities and ecosystems structure and functioning (DeJong 1975) [6]. Diversity is the basic concept that is used to denote the community structure. It has been defined by the indices used to measure it. Whittaker and Woodwell's (1969) alpha diversity is the within-habitat or intracommunity diversity that is the subject of the present consideration. He has advocated using the Simpson index to express relative concentration of dominance that is, measures of slope of the importance value sequence, but differentiating between Simpson's index for concentration of dominance and Shannon's formula as an index of equitability. We dealt with site-wise species diversity indices of anurans at the study locations (Table 2).

Table 2: Calculated diversity indices of all the study sites of Aurangabad Bihar

Diversity index	Site- I	Site- II	Site -III
Shannon-Wiener Diversity Index (H')	1.213	1.969	1.849
Simpson's Dominance Index (D_{SIMP})	0.149	0.231	0.169
Margalef Richness Index (D_{MARG})	0.693	1.325	1.243
Pielou's Evenness Index (J')	0.932	0.832	0.853

The Shannon–Wiener species diversity index ($H^{'}$), based mainly on proportional species abundances, was observed to be minimum at site-I (1.213) while comparable high values were calculated from site-II (1.969) and site-III (1.849). These two sites were moist and contain both lotic and lentic water bodies, high anuran diversity were recorded in site-II and site-III. Evenness is an important property of all ecological communities. It may be defined as ''the degree to which the abundances are equal among the species present ina sample or community'' (Molinari, 1989). A community in which each species present is equally abundant has high evenness; a community in which the species differ widely in abundance has low evenness (Smith and Wilson, 1996). Pielou's index (J^0) of evenness was also very high for site-I (0.932) and site-III (0.853) while minimum at site-II (0.832). Simpson's dominance index (DSIMP), which is also based on proportional abundance like H' revealed contrasting values to those of H'. The maximum was recorded from site-II (0.231) while comparatively much lower values at site-I (0.149) and at site-III (0.169) were calculated. Although both Shannon–Wiener and Simpson's indices consider the proportional abundance of species, $H^{'}$ is more sensitive to rare species, where as DSIMP put greater emphasis to common species. Therefore these indices point out occurrence of many diverse anuran species at site-II and site-III while only specially adapted species are confined to site-I. The use of diversity indices has increased due to the necessity of testing different methodologies to develop the ecological status. Richness is an indicator of the relative wealth of species in a community. The species richness (total number of species in each sample), and Margalef index, considering either the absolute number of individuals or the density, were calculated (Gamito 2010). The percentage variation was calculated
as the ratio of Margalef index determined with the density matrix divided by the Margalef index determined with the absolute numbers matrix. Margalef's richness index (DMARG), which considers both abundance and species numbers, also indicated that maximum values were associated with site-II (1.325) and site-III (1.243) while the minimum for the site-II (0.693). Anurans are moisture loving creatures. Therefore the species diversity is expected to be high in moist places. This could well be substantiated from the data recorded from site- II and site-III in the present study. However, perhaps to avoid competition some of the anuran species of Aurangabad Bihar have adapted large forest area as in evident from the data recorded from various sites
Therefore, the anuran diversity is high in the study area

compared to other parts of lower Indo-Gangetic plains of the state of Bihar of India. It is apparent from the study that still good habitat diversity encouraging nine species to thrive in Aurangabad Bihar. Alongside, it is also evident that the township, criss-crossed with a good number of roadways with heavy traffic loads, experienced a very heavytoll on anuran population through road-kill, especially during monsoon.

5. Conclusion

Aurangabad Bihar is the southernmost state of Bihar surrounded by hilly and forested areas. It also having large number of water bodies supported great variety of floral and faunal diversity. In my study 9 species of amphibians identified and recorded from various study sites of the district. This will the first account about the amphibian diversity and habitat preference of this area.

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