



# Anurans of Gaya District, Bihar, India

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The amphibian fauna of Bihar, India, is not well known. Venkateswarulu and Murthy (1972) listed 11 species of anurans, Sarkar (1991) listed 11 species from the Chota-Nagpur Hills in Bihar, and Sarkar et al. (2004) listed 14 species from Bihar (including Jharkhand). However, no sources document the amphibian diversity of Gaya District. The Gaya District (24.7969°N, 85.9994°E) covers 4,976 km<sup>2</sup> at elevations of 94–104 m asl in southern Bihar. Average annual rainfall is 1,100–1,300 mm, most of which falls during the monsoon. Temperatures range from a low of 4 °C in winter to a high of 45 °C in summer with relative humidity of 15–19% and 62–98%, respectively. Vegetation is largely dry deciduous forest dominated by Sal trees (*Shorea robusta*) interspersed with grasslands and cultivated areas. The Falgu, Morhar, and Sorhar Rivers and a number of temporary and permanent ponds, lakes, and wetlands provide aquatic habitats.

Twice daily (0530–0800 h and 1900–2300 h) from March 2017 to February 2018, we used visual-encounter surveys, point-count surveys, call surveys, and opportunistic encounters to assess the composition of amphibian communities at three sites in the district: (1) Ramsagar Pond (24.7735°N, 85.0320°E; Fig. 1A) is a large permanent artificial pond covering a 821.5-m<sup>2</sup> area with a mean depth of 2 m in densely populated Gaya (city). In addition to the main pond, we also surveyed small temporary pools in the

immediate vicinity. (2) Daboor Village Pond (24.8112°N, 84.7259°E; Fig. 1B) is a 2-ha pond in a catchment area of about 8 ha with grasslands and agricultural fields. In addition to the main pond, we also surveyed 15–20 ephemeral pools in the immediate vicinity. (3) A 7–10-km stretch of the Falgu River (24.7528°N, 84.1299°E; Fig. 1C), drains a catchment area about 16 ha, much of which is inundated during the monsoon season.

We identified frogs using keys and descriptions in Dubois (1975), Bossuyt and Dubois (2001), Dutta and Manamendra-Arachchi (1996), Chanda (2002), Daniels (2005), Das (2008), Ahmed et al. (2009), Kabir et al. (2009), and Frost (2020). We recorded habitat for each frog encountered and collectively assessed the relative abundance of species as in Khan (2008): Very common (VC) = 76–100% chance of being encountered when most active in suitable habitat; common (C) = 51–75% chance of being encountered; uncommon (UC) = 26–50% chance of being encountered, and rare (R) ≤ 25% chance of being encountered. We calculated Shannon-Wiener diversity index, Pielou evenness index, Margalef richness index, and Simpson dominance index to compare the diversity and composition of anural communities at each site.

We encountered ten species of anurans in seven genera and four families from the three sites (Table 1; Fig. 2). All



**Fig. 1.** Aquatic habitats at the study site in Gaya District, Bihar, India: (A) Ramsagar Pond in Gaya; (B) Daboor Village Pond; and (C) Falgu River. Photographs by Nalinaksh Pankaj.

**Table 1.** Anurans encountered at the study site in Gaya District, Bihar, India. Habitat: LL&BG = leaf litter & bamboo grooves, TH = tree hole, HRA = human residential area, CF = cultivated fields, PG = patchy grasslands, FH = forested hills, T = terrestrial, AQ = bodies of water. Abundance: VC = very common, C = common, UC = uncommon, R = rare.

Species	Habitat	Abundance	Percent Relative Abundance		
			Site 1	Site 2	Site 3
<b>Bufonidae</b>					
Common Asian Toad (Fig. 2A)					
<i>Duttaphrynus melanostictus</i> (Schneider 1799)	HRA, FH, T	C	8.8	9.2	10.4
Marbled Toad (Fig. 2B)					
<i>Duttaphrynus stomaticus</i> (Lütken 1864)	T, HRA, LL&BG	VC	14.9	13.1	12.8
<b>Dicroglossidae</b>					
Skittering Frog (Fig. 2C)					
<i>Euphlyctis cyanophlyctis</i> (Schneider 1799)	AQ, CF	VC	20.2	20.0	16.8
Asian Cricket Frog (Fig. 2D)					
<i>Fejervarya limnocharis</i> (Gravenhorst 1829)	AQ, CF	UC	2.6	3.1	6.4
Jerdon's Bullfrog (Fig. 2E)					
<i>Hoplobatrachus crassus</i> (Jerdon 1853)	AQ, T, CF, FH, PG	C	8.8	10.0	9.6
Indian Bullfrog (Fig. 2F)					
<i>Hoplobatrachus tigerinus</i> (Daudin 1802)	AQ, T, CF, FH, PG	VC	18.4	17.7	19.2
Indian Burrowing Frog (Fig. 2G)					
<i>Sphaerotheca breviceps</i> (Schneider 1799)	FH, PG, T	UC	6.1	9.2	5.6
Roland's Burrowing Frog					
<i>Sphaerotheca rolandae</i> (Dubois 1983)	FH, PG, T	R	3.5	—	4.0
<b>Microhylidae</b>					
Marbled Balloon Frog					
<i>Uperodon systema</i> (Schneider 1799)	FH, near AQ	R	3.5	—	—
<b>Rhacophoridae</b>					
Common Indian Treefrog (Fig. 2H)					
<i>Polypedates maculatus</i> (Gray 1830)	HRA, T, TH, FH	C	13.2	17.7	15.2

were present in the Ramsgar Pond (site 1), eight species in six genera and four families were present in the area around the Daboor Village Pond (site 2), and nine species in seven genera and four families were present in the area around the Falgu River (site 3). All of the species encountered have been assessed as being of Least Concern (LC) on the IUCN Red List of Threatened Species (IUCN 2020).

The Marbled Toad (*Duttaphrynus stomaticus*), Skittering Frog (*Euphlyctis cyanophlyctis*), Indian Bullfrog (*Hoplobatrachus tigerinus*), and Common Indian Treefrog (*Polypedates maculatus*) were found in a variety of habitats at all three sites. The Common Asian Toad (*Duttaphrynus melanostictus*), Asian Cricket Frog (*Fejervarya limnocharis*), and Jerdon's Bullfrog (*Hoplobatrachus crassus*) were found in

smaller numbers and mainly in agricultural fields and suburban areas. The Indian Burrowing Frog (*Sphaerotheca breviceps*), Roland's Burrowing Frog (*Sphaerotheca rolandae*), and Marbled Balloon Frog (*Uperodon systema*) were the least frequently encountered species and the latter two were absent from one or two sites.

Of the calculated diversity indices (Table 2), all of which consider both species richness and relative abundance, the Shannon-Wiener index was lower at site 2 than at sites 1 and 3. This might reflect a greater habitat diversity as the latter sites have both lotic and lentic systems, although the Simpson index, which is less sensitive to rare species and thus places a greater emphasis on common species, was highest at site 2, as was the Margalef index. Evenness reflects the degree to which



**Fig. 2.** Anurans encountered at the study site in Gaya District, Bihar, India: (A) Common Asian Toad (*Duttaphrynus melanostictus*); (B) Marbled Toad (*Duttaphrynus stomaticus*); (C) Skittering Frog (*Euphlyctis cyanophlyctis*); (D) Asian Cricket Frog (*Frejervarya limnocharis*); (E) Jerdon's Bullfrog (*Hoplobatrachus crassus*); (F) Indian Bullfrog (*Hoplobatrachus tigerinus*); (G) Indian Burrowing Frog (*Sphaerotheca breviceps*); (H) Common Indian Treefrog (*Polypedates maculatus*). Photographs by Nalinaksh Pankaj.

**Table 2.** Calculated biodiversity indices for three habitats at the study site in Gaya District, Bihar, India: (1) Ramsagar Pond in Gaya; (2) Daboor Village Pond; and (3) Falgu River.

Diversity Index	Site 1	Site 2	Site 3
Shannon-Wiener Diversity Index (H)	2.114	1.978	2.092
Simpson Dominance Index ( $D_{\text{SIMP}}$ )	0.136	0.147	0.136
Margalef Richness Index ( $D_{\text{MARG}}$ )	1.900	1.438	1.657
Pielou Evenness Index (J)	0.918	0.951	0.952

the relative abundance of various species in a community is equal (Molinari 1989). Pielou's evenness index was higher for sites 2 and 3 than site 1.

Despite the fact that our study revealed moderate diversity at all three sites and some species were very abundant, we noticed habitat loss, alteration, and fragmentation to various degrees at all sites. At site 1, urbanization was largely responsible, whereas at sites 2 and 3, agricultural practices were to blame. We also observed a number of direct threats, including road mortality and the extensive use of pesticides and herbicides.

Our assessment of anuran diversity was intended to establish a preliminary baseline for further studies that should include efforts to identify additional species, more closely examine habitat associations, and quantify population sizes and trends. These will be necessary to evaluate the severity

of the threats and also to propose conservation strategies for these communities.

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