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Pattern of Change of Anuran Diversity in Urban and Semi-Urban Areas of North 24 Parganas

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ABSTRACT

Field studies were carried out covering the period from 2023 to 2025 in different urban and semi-urban areas of North 24 Parganas district, West Bengal, to understand the pattern of occurrence and distribution of anuran species and the environmental characteristics of their habitats. Five study regions, namely Naihati, Helencha, Gobardanga, Guma and Barasat, representing different degrees of urbanization and habitat modification, were selected for the study.

The study was restricted to two anuran species, namely *Duttaphrynus melanostictus* and *Hoplobatrachus tigerinus*. Field observations included adult, juvenile and tadpole stages. Adult specimens were recorded according to sex and study site, while environmental parameters of aquatic and surrounding habitats were also documented. A total of 3,136 adult specimens were recorded during the study period, comprising 1,893 *D. melanostictus* and 1,243 *H. tigerinus*. In addition, 4,825 juveniles and 6,425 identified tadpoles were recorded.

Among the five study sites, Guma recorded the highest number of adults, followed by Gobardanga, Helencha, Barasat and Naihati. *D. melanostictus* was more abundant than *H. tigerinus* at all five sites. The male-to-female sampled ratio was approximately 1.17:1 in *D. melanostictus* and 1.22:1 in *H. tigerinus*. A chi-square test of independence indicated no statistically significant association between study site and species composition of adult specimens ($\chi^2 = 2.698$, df = 4, $p = 0.609$). Shannon diversity values based on the two recorded adult species ranged from 0.662 to 0.679 across the five sites.

The observed distribution indicates that both species continue to occur across urban and semi-urban habitats, although their relative abundance differs among locations. Habitat characteristics, availability of aquatic breeding sites, urbanization, water quality, vegetation and human disturbance may influence their local occurrence. However, the available data do not support causal inference regarding individual environmental variables because environmental observations are provided mainly as site-level measurements rather than independent replicated observations linked directly to abundance.

Keywords: Anuran diversity; Duttaphrynus melanostictus; Hoplobatrachus tigerinus ; amphibians; urbanization; semi-urban habitat; North 24 Parganas; habitat ecology.

INTRODUCTION

India supports a highly diverse amphibian fauna comprising species belonging to the orders Anura, Gymnophiona and Caudata. Amphibians occupy an important position in terrestrial and aquatic ecosystems and contribute to nutrient cycling, food-web interactions and natural control of insect populations. At the same time, amphibians are particularly sensitive to environmental changes because of their dependence on both aquatic and terrestrial habitats.

North 24 Parganas is one of the highly populated districts of West Bengal and contains a mixture of natural, agricultural, semi-urban and urban habitats. The district contains wetlands, ponds, canals, agricultural fields, gardens, drainage systems, villages, urban settlements and areas undergoing rapid infrastructural development. Such habitat heterogeneity provides suitable conditions for amphibians but simultaneously exposes them to increasing anthropogenic pressure.

The present study was undertaken to examine the occurrence and distribution of anurans in different urban and semi-urban areas of North 24 Parganas. The study considered two species, *Duttaphrynus melanostictus* and *Hoplobatrachus tigerinus* , which utilize different but partially overlapping habitat types.

Duttaphrynus melanostictus (Schneider, 1799), commonly known as the Asian common toad or black-spectacled toad, is widely distributed and associated with a broad range of habitats. Its tolerance of human-modified environments allows it to occur in residential areas, gardens, roadsides, agricultural fields and aquatic habitats.

Hoplobatrachus tigerinus (Daudin, 1802), commonly known as the Indian bull frog, belongs to the family Dicroglossidae. It is generally associated with aquatic and semi-aquatic habitats such as ponds, canals, marshes, ditches, paddy fields and other inundated areas.

MATERIALS AND METHODS

Study Areas

The study was conducted in five regions of North 24 Parganas district, West Bengal: Naihati, Helencha, Gobardanga, Guma and Barasat. The selected regions represent a combination of urban, semi-urban and human-modified habitats. The habitats investigated included ponds, seasonal water bodies, agricultural areas, gardens, roadside water bodies, drainage areas and human settlements.

Visual Encounter Survey

Visual Encounter Survey (VES) was used for field observation and recording of anuran specimens. Individuals were recorded from different habitat patches and identified using external morphological characters and available taxonomic resources. Adult sampling was documented during July–November 2023, March–May 2024, June–November 2024 and March–November 2025.

Species Identification

Two anuran species were identified during the study. *Duttaphrynus melanostictus* was identified by its warty dorsal surface, black-tipped warts, distinct tympanum and weak toe webbing. *Hoplobatrachus tigerinus* was characterized by its yellowish body with green appearance on the sides, longitudinal folds on the back, strong fold above the tympanum and characteristic light bands.

Environmental Measurements

Aquatic and soil parameters were documented for the study habitats. Parameters included aquatic pH, dissolved oxygen, free carbon dioxide, hardness, salinity and water temperature, together with soil organic carbon, specific gravity and soil pH. Atmospheric temperature and relative humidity were also recorded. Environmental values are presented descriptively because the available records are primarily site-level observations rather than independent replicated observations directly matched with abundance measurements.

Statistical Analysis

Adult abundance was summarized by study site, species and sex. A chi-square test of independence was applied to the site × species adult-count contingency table. Shannon diversity (H') and Simpson diversity ($1-D$) were calculated from relative abundance of the two adult species at each site. Because the environmental dataset does not provide sufficient independent replicated observations paired with population counts, environmental ANOVA and correlation analyses were not used to make causal claims.

RESULTS AND DISCUSSION

Site-wise Adult Abundance

Study site	*D. melanostictus* Male	*D. melanostictus* Female	*D. melanostictus* Total	*H. tigerinus* Male	*H. tigerinus* Female	*H. tigerinus* Total	Combined
Naihati	154	123	277	100	81	181	458
Helencha	211	175	386	135	106	241	627
Gobardanga	235	215	450	164	131	295	745
Guma	255	229	484	190	157	347	831
Barasat	165	131	296	94	85	179	475
Total	1020	873	1893	683	560	1243	3136

A total of 3,136 adult specimens were recorded. *D. melanostictus* accounted for 1,893 specimens (60.4%), while *H. tigerinus* accounted for 1,243 (39.6%). Guma recorded the highest combined adult abundance (831), followed by Gobardanga (745), Helencha (627), Barasat (475) and Naihati (458).

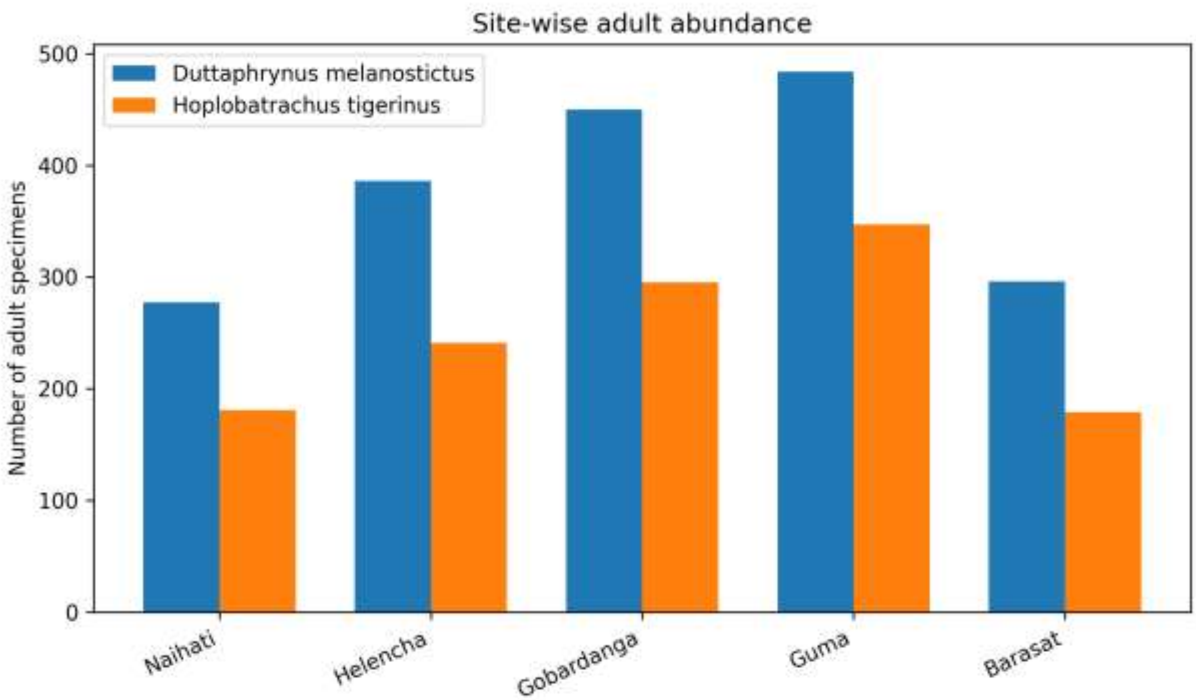

Figure 1. Site-wise adult abundance of *Duttaphrynus melanostictus* and *Hoplobatrachus tigerinus* .

Temporal Pattern of Adult Sampling

Sampling period	*D. melanostictus*	*H. tigerinus*	Combined
Jul–Nov 2023	322	231	553
Mar–May 2024	229	151	380
Jun–Nov 2024	481	407	888
Mar–Nov 2025	861	454	1315
Total	1893	1243	3136

The temporal records show increasing numbers of recorded adults during the later sampling period, particularly March–November 2025. These figures represent recorded specimens under the field sampling design and should not automatically be interpreted as direct estimates of population growth because sampling duration and intensity may vary among periods.

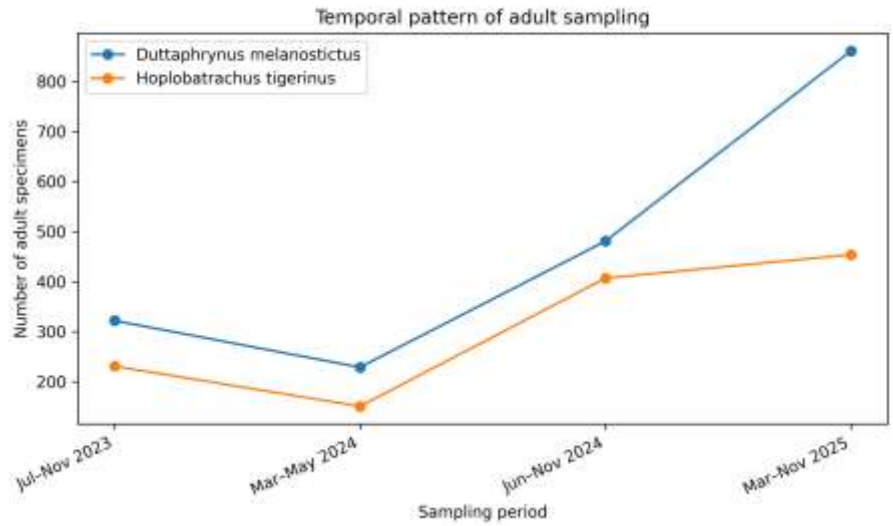

Figure 2. Temporal pattern of adult sampling.

Sex Composition

Site	*D. melanostictus* Male	*D. melanostictus* Female	*H. tigerinus* Male	*H. tigerinus* Female
Naihati	154	123	100	81
Helencha	211	175	135	106
Gobardanga	235	215	164	131
Guma	255	229	190	157
Barasat	165	131	94	85
Total	1020	873	683	560

The sampled male:female ratio was approximately 1.17:1 in *D. melanostictus* and 1.22:1 in *H. tigerinus*. These ratios describe the composition of the sampled specimens and should not be interpreted as definitive population sex ratios.

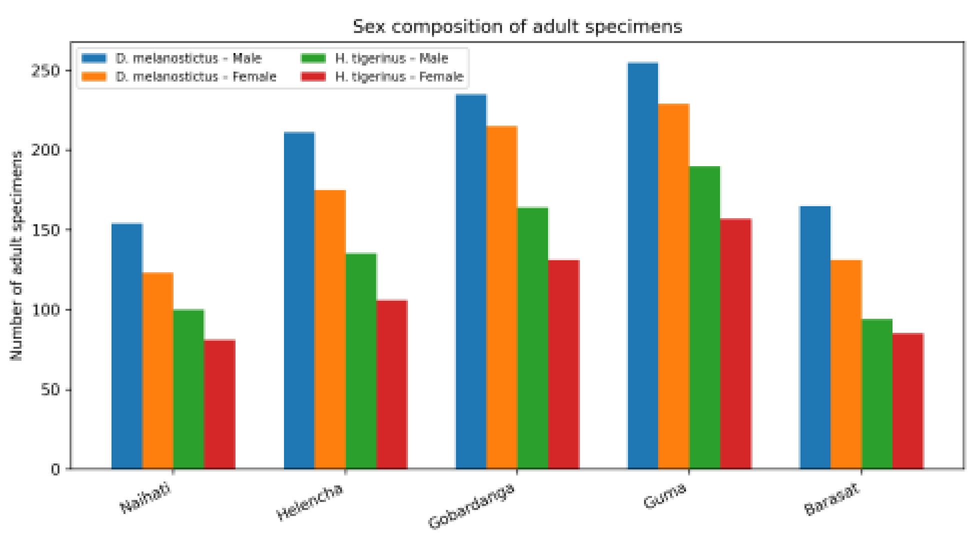

Figure 3. Sex composition of adult specimens across the five study sites.

Juvenile Abundance

Species	Number of juveniles
D. melanostictus	2850
H. tigerinus	1975
Total	4825

A total of 4,825 juveniles were recorded during July 2023–November 2025.

Tadpole Abundance

Species	Number of tadpoles
D. melanostictus	3645
H. tigerinus	2780
Unidentified	1574

A total of 6,425 identified tadpoles were recorded, together with 1,574 unidentified tadpoles. The unidentified tadpoles were not assigned to either species for species-specific analysis.

Species Diversity across Study Sites

Study site	Total adults	*D. melanostictus* (%)	*H. tigerinus* (%)	Shannon H′	Simpson 1-D
Naihati	458	60.48	39.52	0.671	0.478
Helencha	627	61.56	38.44	0.666	0.473
Gobardanga	745	60.40	39.60	0.671	0.478
Guma	831	58.24	41.76	0.679	0.486
Barasat	475	62.32	37.68	0.662	0.470

Shannon diversity values were relatively similar among the five locations, ranging from 0.662 in Barasat to 0.679 in Guma. The comparatively higher value at Guma reflects the relatively balanced representation of the two recorded species.

Chi-Square Analysis

Statistic	Value
Chi-square (χ^2)	2.698
Degrees of freedom	4
p-value	0.609
Significance level	0.05

The chi-square test was not statistically significant ($p = 0.609$). Therefore, based on the recorded adult counts, there is no statistical evidence of an association between study site and relative distribution of the two species.

Environmental Characteristics

The environmental records indicate mildly acidic to near-neutral aquatic pH values, moderate dissolved oxygen concentrations and low recorded salinity across the investigated habitats. Aquatic pH generally remained within approximately 6.08–7.28, dissolved oxygen ranged from approximately 7.53–9.76 and free carbon dioxide generally ranged from approximately 9.87–13.38. Soil organic carbon values were generally between approximately 5.85 and 6.83 g/kg and soil pH remained approximately between 7.11 and 7.51.

These measurements are useful for describing habitat conditions. However, they should not be interpreted as evidence that any particular environmental variable caused differences in frog abundance. Robust correlation or regression analysis would require matched replicate environmental observations and abundance measurements at equivalent sampling units.

DISCUSSION

The present investigation provides a field-based account of the occurrence of two anuran species across five regions of North 24 Parganas. The data demonstrate that *Duttaphrynus melanostictus* and *Hoplobatrachus tigerinus* occur in both urban and semi-urban landscapes and utilize a variety of aquatic and terrestrial habitat patches.

The most prominent pattern was the consistently greater abundance of *D. melanostictus*. At each of the five sites, the number of recorded *D. melanostictus* adults exceeded the number of *H. tigerinus* adults. This pattern was also reflected in juvenile and tadpole records.

The relatively high representation of *D. melanostictus* may be related to its ability to tolerate human-modified habitats. Human settlements can provide shelter and feeding opportunities, while artificial lighting and associated insect abundance may provide additional food resources.

H. tigerinus showed lower abundance than *D. melanostictus* at all sites. Its association with aquatic habitats means that changes in water availability, aquatic vegetation, wetland condition, agricultural practices and habitat disturbance may have implications for its local occurrence.

The highest number of adult specimens was recorded at Guma, while Naihati had the lowest total. These differences may reflect habitat availability, accessibility, local abundance and sampling conditions and should not be interpreted solely as differences in absolute population size.

The presence of juvenile and larval stages indicates utilization of the investigated habitats during different stages of the amphibian life cycle. Continued monitoring is therefore important for understanding recruitment and long-term persistence.

Urbanization remains an important potential pressure on amphibian habitats. Habitat destruction, wetland loss, road construction, increasing traffic, drainage modification, water pollution, agricultural chemicals and infrastructure development can reduce habitat quality and connectivity. Fragmentation can also reduce movement between suitable habitat patches and potentially affect long-term population persistence.

Conservation Implications

1. Protection of existing ponds and wetlands.
2. Maintenance of seasonal water bodies used for breeding.
3. Reduction of unnecessary disturbance around breeding sites.
4. Control of water pollution and indiscriminate chemical discharge.
5. Maintenance of vegetation around aquatic habitats.
6. Reduction of road mortality during seasonal movements.
7. Maintenance of connectivity between suitable habitat patches.
8. Public awareness regarding the ecological importance of amphibians.
9. Long-term monitoring of population abundance and recruitment.
10. Integration of molecular and ecological studies to assess population connectivity.

CONCLUSION

The present study demonstrates that *Duttaphrynus melanostictus* and *Hoplobatrachus tigerinus* are distributed across the investigated urban and semi-urban habitats of North 24 Parganas.

A total of 3,136 adult specimens were recorded, of which 1,893 belonged to *D. melanostictus* and 1,243 to *H. tigerinus*. Guma recorded the highest number of adult specimens, followed by Gobardanga, Helencha, Barasat and Naihati. *D. melanostictus* was consistently more abundant than *H. tigerinus* at all five study sites.

A total of 4,825 juveniles and 6,425 identified tadpoles were documented. An additional 1,574 tadpoles remained unidentified and were therefore excluded from species-specific analyses.

Shannon diversity values were relatively similar across the five study sites. The chi-square analysis did not demonstrate a statistically significant association between site and species composition ($\chi^2 = 2.698$, $df = 4$, $p = 0.609$).

The findings indicate that *D. melanostictus* has a relatively broad representation across the human-modified landscape, while *H. tigerinus* also remains widely distributed but at comparatively lower recorded abundance. Continued habitat monitoring, wetland protection, reduction of anthropogenic disturbance and maintenance of connectivity between habitat patches are important for long-term conservation of anuran populations in the region.

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