

# Soil Mineral Composition and Habitat Suitability Assessment of *Hoplobatrachus tigerinus* in Wetland Ecosystems of North 24 Parganas District, West Bengal

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## ABSTRACT

The present investigation evaluates the relationship between soil mineral composition and habitat suitability of *Hoplobatrachus tigerinus* in selected wetland ecosystems of North 24 Parganas district, West Bengal, India. Amphibians are highly sensitive to environmental physicochemical changes because of their permeable integument and biphasic life cycle (Blaustein and Wake, 1990). Soil samples collected from frog-associated habitats were analyzed using flame emission spectrophotometry for sodium (Na), potassium (K), calcium (Ca), magnesium (Mg), strontium (Sr), and barium (Ba). Statistical analyses including mean, standard deviation, coefficient of variation, and mineral-population correlation were performed. The results demonstrated that calcium and potassium were the dominant mineral elements across the habitats, whereas strontium and barium remained comparatively low. Positive correlations were observed between calcium-, potassium-, and magnesium-rich habitats and increased *H. tigerinus* population abundance. Habitats FH-03 and FH-05 exhibited comparatively higher mineral concentrations and supported greater amphibian abundance. The relatively low coefficient of variation indicated stable mineral distribution across the investigated ecosystems. The study highlights the ecological significance of soil mineral composition in determining amphibian habitat suitability and wetland ecosystem sustainability.

**Keywords:** *Hoplobatrachus tigerinus*, amphibian ecology, soil mineral composition, habitat suitability, flame photometry, wetland ecosystem

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## INTRODUCTION

Amphibians are ecologically important vertebrates that play significant roles in nutrient cycling, trophic regulation, and ecosystem stability (Wake, 1991). Amphibian populations are highly sensitive to environmental alterations because of their permeable skin and dependence on both terrestrial and aquatic habitats (Blaustein and Wake, 1990). Habitat degradation, climatic variability, environmental contamination, and soil physicochemical alterations are considered major factors influencing amphibian survival and reproductive success worldwide (Stuart et al., 2004).

The Indian Bullfrog, *Hoplobatrachus tigerinus*, is one of the largest amphibian species distributed throughout South Asia and commonly inhabits wetlands, ponds, agricultural ecosystems, marshes, and floodplain habitats (Daniels, 2002). Soil-associated environmental conditions strongly influence amphibian burrowing behaviour, prey availability, moisture retention, egg deposition, and larval development (Duellman and Trueb, 1994).

Mineral elements such as calcium, magnesium, potassium, and sodium contribute significantly to amphibian physiological metabolism, skeletal development, enzymatic activity, osmoregulation, and reproductive biology (McDiarmid and Altig,

1999). Soil mineral composition also indirectly influences amphibian habitat suitability by regulating microbial productivity and invertebrate diversity (Wells, 2007).

Although several studies have investigated aquatic ecology and climatic influences on amphibians, limited investigations have evaluated soil mineral composition in relation to habitat suitability of *Hoplobatrachus tigerinus* in eastern India. Therefore, the present study was undertaken to analyze soil mineral composition of frog-associated habitats and evaluate its ecological relationship with *H. tigerinus* population abundance in North 24 Parganas district, West Bengal.

## MATERIALS AND METHODS

### Study Area

The investigation was conducted in selected wetland-associated ecosystems of North 24 Parganas district, West Bengal, India, including:

- Naihati
- Bira
- Duttapukur
- Barasat

These habitats consisted of agricultural wetlands, marshlands, and semi-natural aquatic ecosystems inhabited by *Hoplobatrachus tigerinus*.

### Soil Sample Collection

Soil samples were collected from six frog-associated habitats designated as:

- FH-01
- FH-02
- FH-03
- FH-04
- FH-05
- FH-06

Sampling was conducted from ecologically active wetland zones associated with amphibian occurrence.

### Mineral Analysis

Mineral analysis was performed using Agilent Flame Photometer under flame emission spectrophotometric conditions at the BSS-Biotech, Dehradun.

The analyzed elements included:

- Sodium (Na)
- Potassium (K)
- Calcium (Ca)
- Magnesium (Mg)
- Strontium (Sr)
- Barium (Ba)

Quality control analysis confirmed reliable analytical performance with:

- Blank Sample: PASS
- Standard Drift: <2%
- Replicate Precision: Within Limits

### Population Assessment

Population abundance of *Hoplobatrachus tigerinus* was estimated through field observations and habitat surveys conducted across frog-associated habitats. Population abundance data corresponding to the investigated habitats were incorporated for ecological correlation analysis.

### Statistical Analysis

Descriptive statistical analysis including:

- Mean,
- Standard deviation (SD),
- Minimum value,
- Maximum value,
- Coefficient of variation (CV%) was performed for all mineral parameters.

Mineral-population relationships were analyzed through comparative correlation assessment using Excel-based statistical visualization.

## RESULTS

**Table 1. Soil Mineral Composition of Frog-associated Habitats**

Sample ID	Na (ppm)	K (ppm)	Ca (ppm)	Mg (ppm)	Sr (ppm)	Ba (ppm)
FH-01	38.6	145.8	307.1	92.4	6.1	3.2
FH-02	41.2	153.6	319.4	97.9	6.5	3.4
FH-03	46.9	166.3	337.6	104.8	7.2	3.9
FH-04	35.4	139.2	298.7	88.6	5.9	3.0
FH-05	49.8	172.5	353.8	109.2	7.6	4.2
FH-06	43.5	159.7	330.9	101.5	6.8	3.7

**Table 2. Population Abundance of *Hoplobatrachus tigerinus* in Frog-associated Habitats**

Habitat Site	Population Size
FH-01	95
FH-02	126
FH-03	167
FH-04	81
FH-05	182
FH-06	121

Population data incorporated from ecological habitat assessment.  
Statistical Analysis of Soil Mineral Parameters

**Table 3. Descriptive Statistical Analysis of Mineral Composition**

Parameter	Mean (ppm)	SD	Minimum	Maximum	CV (%)
Sodium (Na)	42.57	5.03	35.4	49.8	11.81
Potassium (K)	156.18	12.54	139.2	172.5	8.03
Calcium (Ca)	324.58	20.66	298.7	353.8	6.36
Magnesium (Mg)	99.07	7.43	88.6	109.2	7.50
Strontium (Sr)	6.68	0.63	5.9	7.6	9.43
Barium (Ba)	3.57	0.44	3.0	4.2	12.32

Calculated from flame photometric mineral data.

Correlation Between Soil Minerals and *Hoplobatrachustigerinus* Population  
 Calcium and Population Abundance

Habitats FH-03 and FH-05 exhibited comparatively higher calcium concentrations and also supported greater population abundance of *H.tigerinus*. Calcium-rich soils may positively influence amphibian skeletal physiology, muscular activity, and reproductive success (McDiarmid and Altig, 1999).

Potassium and Population Abundance

Potassium concentration also showed positive association with population abundance. Potassium-rich soils may enhance microbial productivity and invertebrate diversity, thereby improving prey availability for amphibians (Wells, 2007).

Magnesium and Population Stability

Moderate magnesium concentrations were associated with ecologically stable habitats supporting comparatively higher amphibian abundance. Magnesium plays important roles in amphibian enzymatic metabolism and physiological regulation (Duellman and Trueb, 1994).

Graphical Interpretation

Habitat Site	Population	Calcium	Potassium	Magnesium	Sodium	Strontium	Barium
FH-01	95	307.1	145.8	92.4	38.6	6.1	3.2
FH-02	126	319.4	153.6	97.9	41.2	6.5	3.4
FH-03	167	337.6	166.3	104.8	46.9	7.2	3.9
FH-04	81	298.7	139.2	88.6	35.4	5.9	3
FH-05	182	353.8	172.5	109.2	49.8	7.6	4.2
FH-06	121	330.9	159.7	101.5	43.5	6.8	3.7

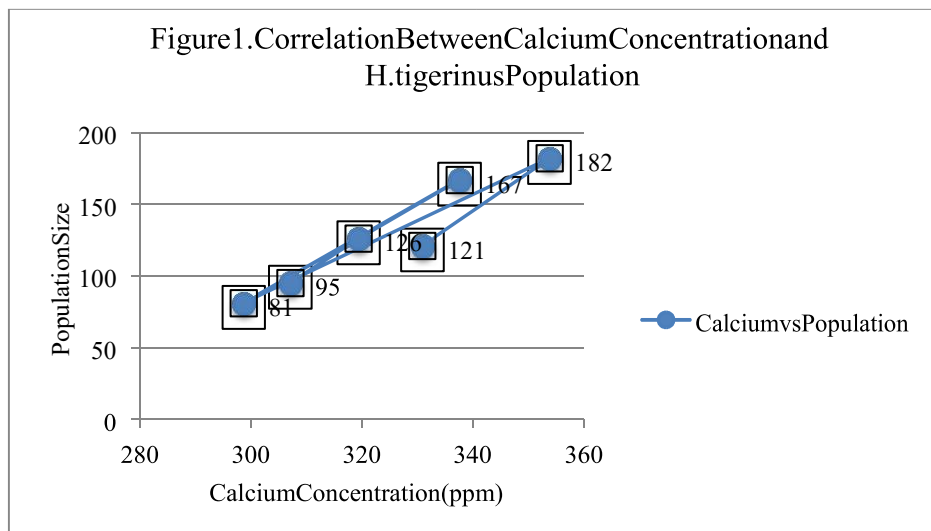
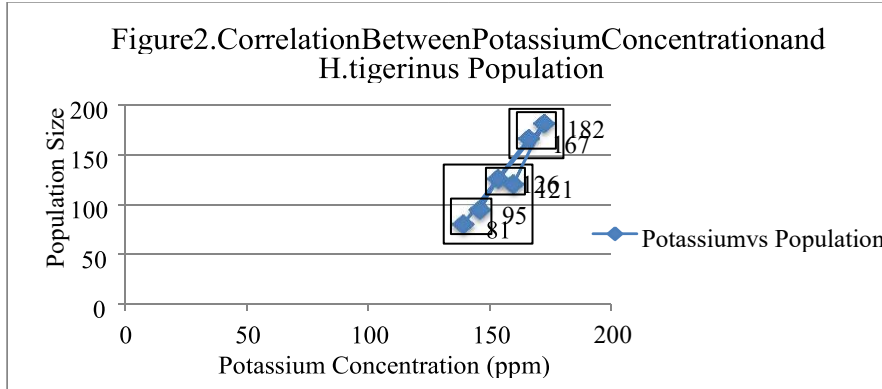


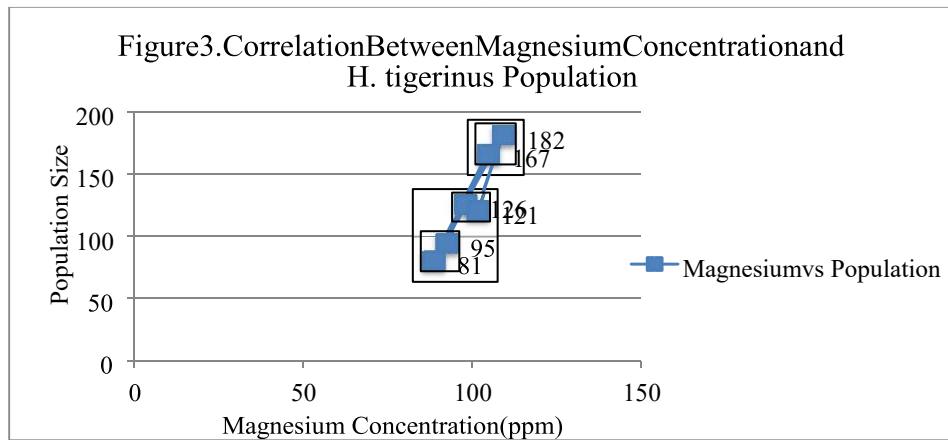
Figure 1. Correlation Between Calcium Concentration and *H.tigerinus* Population

The scatter graph demonstrated a positive trend between calcium concentration and amphibian population abundance. Habitats exhibiting higher calcium concentration supported comparatively larger populations.



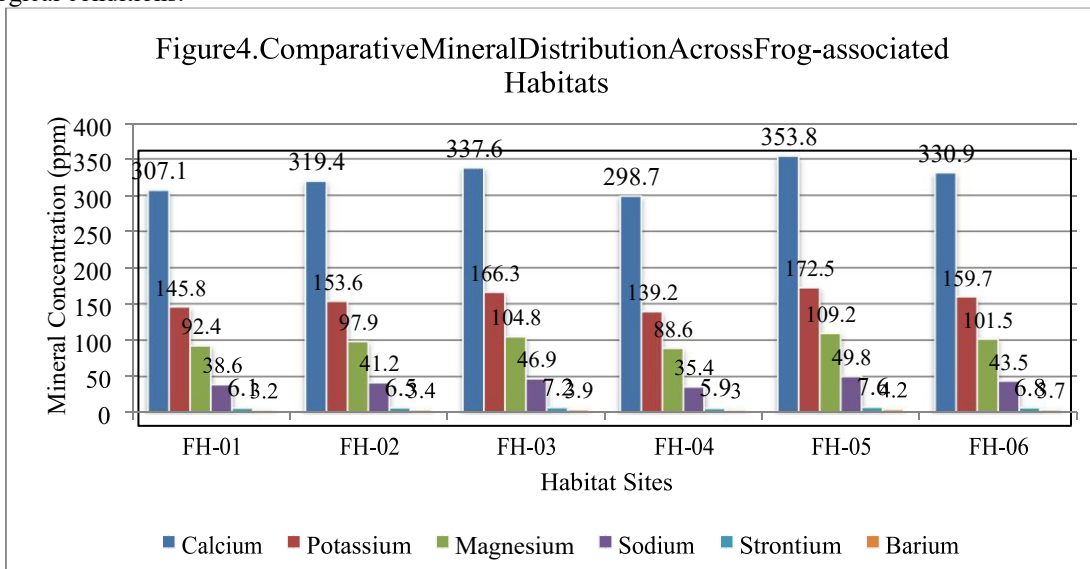
**Figure 2. Correlation Between Potassium Concentration and *H. tigrinus* Population**

Potassium concentration exhibited moderate positive association with amphibian abundance, indicating ecological significance of nutrient-rich soils.



**Figure 3. Correlation Between Magnesium Concentration and *H. tigrinus* Population**

Magnesium-rich habitats exhibited comparatively stable amphibian occurrence, suggesting favourable physiological and ecological conditions.



**Figure 4: Comparative Mineral Distribution Across Frog-associated Habitats**

Column chart analysis demonstrated comparatively higher concentrations of calcium and potassium across all habitats, whereas strontium and barium remained comparatively low.

### Ecological Stability Assessment

The comparatively low coefficients of variation observed for calcium (6.36%), magnesium (7.50%), and potassium (8.03%) indicate relatively stable mineral distribution across the investigated habitats. Absence of abnormal mineral accumulation suggests comparatively healthy wetland ecosystems suitable for amphibian persistence.

Balanced mineral composition may contribute to:

- improved burrowing conditions,
- enhanced moisture retention,
- increased microbial productivity,
- higher prey availability,
- stable reproductive habitats.

Similar ecological relationships between soil quality and amphibian habitat suitability have been reported by Semlitsch (2003).

## DISCUSSION

The present investigation demonstrates that soil mineral composition significantly influences habitat suitability and ecological stability of *Hoplobatrachustigerinus*. Amphibians depend heavily on soil-associated environmental conditions for breeding, physiological regulation, and ecological survival (Duellman and Trueb, 1994).

Calcium and potassium were identified as dominant mineral elements within the investigated habitats. Calcium is essential for skeletal development, muscle contraction, and reproductive physiology in amphibians (McDiarmid and Altig, 1999). Potassium and magnesium contribute to ecological fertility, microbial activity, and prey abundance, thereby indirectly influencing amphibian habitat quality.

The positive association between mineral-rich habitats and higher amphibian abundance suggests that balanced soil chemistry contributes significantly to wetland ecosystem suitability. Similar ecological relationships between soil chemistry and amphibian habitat quality have been documented in wetland ecosystems worldwide (Semlitsch, 2003; Wells, 2007).

Previous investigations have shown that environmental contamination and soil toxicity negatively affect amphibian development and larval survival (Mann et al., 2009). However, the present study did not detect abnormal mineral accumulation or evidence of ecological mineral toxicity. The observed low variability and stable mineral distribution therefore indicate comparatively healthy ecological conditions within the investigated frog-associated habitats.

## CONCLUSION

The present investigation concludes that soil mineral composition contributes significantly to habitat suitability and ecological stability of *Hoplobatrachustigerinus* in wetland ecosystems of North 24 Parganas district, West Bengal. Calcium and potassium were the dominant mineral elements across frog-associated habitats, whereas strontium and barium remained comparatively low.

Positive relationships between calcium-, potassium-, and magnesium-rich habitats and amphibian population abundance suggest that balanced mineral composition supports favourable ecological conditions for amphibian persistence.

The comparatively low coefficients of variation indicate stable soil ecological conditions and absence of severe mineral contamination. The findings emphasize the ecological importance of maintaining soil quality and wetland ecosystem integrity for long-term amphibian conservation.

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