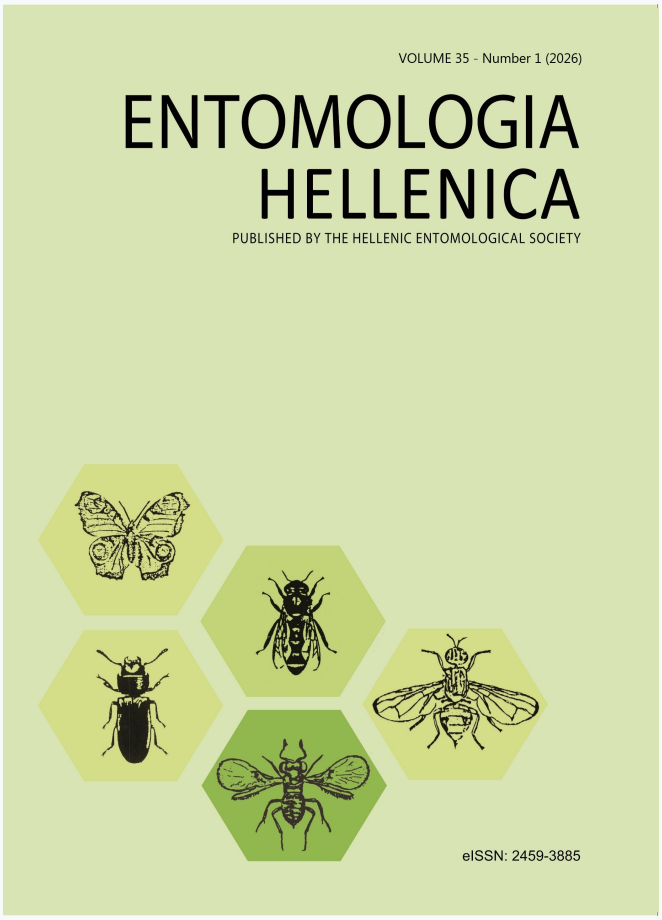
**ENTOMOLOGIA HELLENICA**

Vol 35, No 1 (2026)

Entomologia hellenica 35(1)




# Diversity and species richness of moths in urban green spaces across Guwahati metropolitan city of Assam, India

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**To cite this article:**

Haloi, D. J., Hasan, I., Das, N., & Borah, L. (2026). Diversity and species richness of moths in urban green spaces across Guwahati metropolitan city of Assam, India. *ENTOMOLOGIA HELLENICA*, *35*(1), 12–20. Retrieved from https://ejournals.epublishing.ekt.gr/index.php/entsoc/article/view/41615

ENTOMOLOGIA HELLENICA **35** (2026): 12-36

Received 28 May 2025 Accepted 22 December 2025 Available online 31 January 2026

# Diversity and species richness of moths in urban green spaces across Guwahati metropolitan city of Assam, India

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## ABSTRACT

Moths form a unique group within the order Lepidoptera, playing a crucial role in maintaining ecological balance. Due to their sensitivity to environmental changes, they act as reliable bioindicators, helping ecologists detect even minor ecological disruptions. Guwahati, the largest city in North East India, has undergone substantial urbanization and environmental changes during the recent years. This study aims to assess the potential effects of urbanization on the diversity and species richness of moths within the urban areas of the city. During the course of the study, 168 individual moths were found in the study area. The Shannon-Weiner diversity index values for moth diversity were 2.47 for Hatigaon, 2.133 for Noonmati, and 1.89 for Lokhra, while the Simpson diversity index values 0.093 for Hatigaon, 0.134 for Noonmati, and 0.153 for Lokhra. The Margalef index was highest in Hatigaon (3.040), followed by Noonmati (2.378), and finally Lokhra (1.518). The Pielou Index values were 1 for Hatigaon, 0.96 for Noonmati, and 0.85 for Lokhra. Given the stark contrast between the city's environment and the surrounding natural habitats, understanding the moth fauna in Guwahati can provide valuable insights into the impact of urbanization on local biodiversity.

KEY WORDS: biodiversity, Guwahati, Lepidoptera, moth, urbanization.

## Introduction

Moths are small but vital components of the environment. They belong to the order Lepidoptera, and are important pollinators in agricultural ecosystems (Hahn and Bruhl, 2016) while they play a crucial role in the biodiversity of a particular area (Wagner et al., 2021). Due to their narrow range of environmental tolerance, even slight changes in their natural habitat may have severe impact on their populations. A classic example is Darwin's moths, where intense environmental pollution led to the evolution of a distinctly new phenotype (Cook & Saccheri, 2013). Because of this ecological sensitivity, moths are often used as key indicators of ecosystem health (Parikh et al., 2021). Morphologically, moths are identified by their antennae and wing folding patterns. Moths have feathery, saw-shaped or tapering type of antennae and keep their wings flat while at rest. They are found in nature in diverse colors, shapes and sizes (Kristensen, 2012). While most moths are nocturnal, diurnal species are also observed in certain habitats (Kelber et al., 2003). Globally, around 160,000 moth species have been described, though many more remain undocumented.

Guwahati is the largest city in North East India. Named as the 'Gateway to Northeastern India', the city has undergone rapid expansion during the recent times, with a consequent increase in habitant population. Guwahati is located approximately along 26° 10'N and 92°49'E (GMDA 2007). The city

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is situated on a undulating plain with varying altitudes of 49.5m to 55.5m above mean sea level (MSL). The central part of the city is interspersed with small hillocks like Sarania Hill (193m), Nabagraha Hill (217m), Nilachal Hill (193m) and Chunsali Hill (293m). Structurally, this region is situated on a 50m thick alluvium plane of the middle Brahmaputra valley. The city is a part of Indo-Burma Biodiversity Hotspot and boasts of eight Reserve Forests (South Kalapahar RF, Fatasil RF, Jalukbari RF, Gotanagar RF, Hengrabari RF, Sarania Hill RF, Garbhanga RF, Rani RF) and two Wildlife Sanctuaries (Deeporbeel WLS and Amsing WLS) along with an internationally acclaimed wetland and Ramsar site, the Deeporbeel, within the city boundary. The city climate is homogenous, with a cold and foggy winter (December-February), a moderately cool spring (March-May), a fairly hot and humid summer (June-August) and a pleasant autumn (September-November). However, there are no rigid boundaries between seasons. Summer temperatures range from 22°C to 38°C, while winter temperatures from 10°C to 25°C. The average annual rainfall is 180cm and mainly accumulates during the period from May to September.

Urbanization is one of the primary threats to forest ecosystem health (McKinney, 2002) and it has far-reaching impacts on species diversity and abundance. Over the last three decades, Guwahati has witnessed significant land use and land cover changes. Urban and built-up areas have expanded by 103%, accompanied by a marked decline in vegetation, agricultural lands, and wetlands (Nath et al., 2021). Such rapid urbanization poses serious threats to biodiversity, particularly in tropical countries where urban expansion leads to degrade in natural habitats. In these regions, moth assemblages are not only drastically reduced in number, but the remaining species also differ significantly from those found in natural ecosystems (Gaona et al., 2021).

As cities like Guwahati continue to evolve spatially, socially, economically and, culturally at a rapid pace, it becomes increasingly difficult for the urban flora and fauna to adapt to such abrupt changes (Parnell et al., 2013). Therefore, this study seeks to investigate the diversity and species richness of moths in the urban areas of Guwahati with the scope to understand the impacts of urbanization on this ecologically significant group of insects.


FIG. 1: Map of Guwahati city indicating the study areas viz. Hatigoan, Noonmati and Lokhra.

 

## Materials and Methods

**Study area:** The present study was conducted by selecting three areas within the city namely, Hatigaon, Noonmati and Lokhra (Fig. 1). The Hatigaon area is a locality in southern part of Guwahati city (26.1279°N and 91.7855°E) at the mean sea level of 55.64 m. Noonmati is located at 26.18°N and 91.80°E and Lokhra 26.1116° N, 91.7496° E, is located in southern part of the city.

**Sampling**: In the present experiment nocturnal moths were collected by using light trap (40 W - UV Lamp). The study was conducted over the 6-month period, from January to June, 2022. The samples were collected in the evening from 7:00 P.M. to 12:00 A.M. midnight, then photographed and released back in nature.

**Identification**: The species recorded were identified using available literature such as Moore (1880-1884), Hampson (1891-1896) Holloway (1983-2011) and Kirti and Singh (2015- 2016). The classification system forwarded by Van Nieukerken et al. (2011) was used.

**Measurement of Diversity**: For analysis of the acquired data different diversity indices were calculated including Species richness (the total number of species) and abundance (total number of individuals) for all sampling sites. The statistical analysis was done by Shannon-Weiner diversity index. Simpson's index, Margalef richness index and Pielou's evenness index.

## Results

The study was conducted in three selected urban spaces within the Guwahati city. All the observed moth species were photographed and identified using available literature (Fig. 2). The observations were tabulated (Table 1). During the study period, a total of 14 species were identified from Hatigaon area, 10 from Noonmati and 7 from Lokhra. Among the species identified

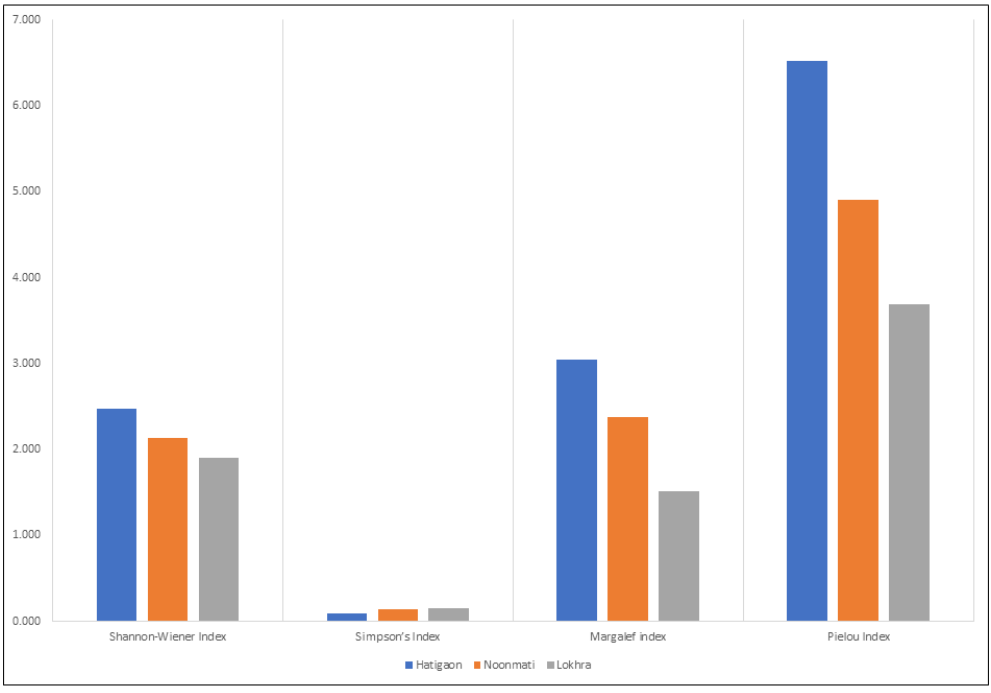


FIG. 2: Graph indicating the comparative analysis of species diversity and richness values of all the study areas within the city.

 

Table 1. List of all observed moth species in the study area.

| Sl. No. | Family | Species | Individuals |
|---|---|---|---|
| **Hatigaon Area** | | | |
| 1 | Pterophoridae | *Sphenarches anisodactylus Walker (1864)* | 5 |
| 2 | Sphingidae | *Manduca rustica* Fabricius (1775) | 7 |
| 3 | Geometridae | *Synchlora aerate* Fabricius (1798) | 3 |
| 4 | Erebidae | *Sphrageidus similis* Fuessly (1775) | 10 |
| 5 | | *Euproctis chrysorrhoea* Linnaeus (1758) | 8 |
| 6 | Tineidae | *Tineola bisselliella* Hummel (1823) | 7 |
| 7 | Crambidae | *Udea Rubigalis* Guenée (1854) | 7 |
| 8 | | *Elophila gyralis* Hulst (1886) | 5 |
| 9 | | *Elophila obliteralis* Walker (1859) | 8 |
| 10 | Geometridae | *Hemithea graminea* Hampson (1891) | 1 |
| 11 | | *Pelagodes antiquadraria* Inoue (1976) | 2 |
| 12 | | *Hypodoxa muscosaria* Guenée (1857) | 2 |
| 13 | | *Tanaorhinus dimissa* Walker (1861) | 1 |
| 14 | Pyralidae | *Pyralis farinalis* Linnaeus (1758) | 6 |
| **Noonmati Area** | | | |
| 1 | Sphingidae | *Manduca rustica* Fabricius (1775) | 7 |
| 2 | Geometridae | *Synchlora aerate* Fabricius (1798) | 3 |
| 3 | | *Pelagodes antiquadraria* Inoue (1976) | 2 |
| 4 | Erebidae | *Sphrageidus similis* Fuessly (1775) | 10 |
| 5 | Tineidae | *Tineola bisselliella* Hummel (1823) | 6 |
| 6 | Arctiidae | *Eugoa basipuncta* Hampson (1891) | 6 |
| 7 | | *Acronicta rumicis* Linnaeus (1758) | 2 |
| 8 | | *Halysidota tessellaris* Smith (1797) | 3 |
| 9 | | *Platyptilia carduidactyla* (Riley, 1869) | 2 |
| 10 | Crambidae | *Pygospila tyres* Cramer (1780) | 3 |
| | | *Elophila* sp. | |
| **Lokhra Area** | | | |
| 1 | Geometridae | *Dysphania militaris* Linnaeus (1758) | 9 |
| 2 | | *Agathia lycaenaria* Kollar (1848) | 4 |
| 3 | Crambidae | *Ostrinia nubilalis* Hübner (1796) | 7 |
| 4 | Erebidae | *Syntomoides imaon* Cramer (1780) | 11 |
| 5 | | *Amata phegea* Linnaeus (1758) | 6 |
| 6 | | *Olepa ocellifera* Walker (1855) | 8 |
| 7 | Noctuoidae | *Alypia octomaculata* Fabricius (1775) | 7 |

 

from Hatigaon area, 5 belonged to the family Geometridae, 3 to Crambidae, 2 to Eribidae, 1 to Pterophoridae, 1 to Pyralidae, 1 to Sphingidae and 1 to Tineidae. Among the moths identified from Noonmati area, 4 belonged to the family Arctiidae, 2 to Geometridae, 1 to Sphingidae, 1 to Tineidae, 1 to Eribidae and 1 to Crambidae. Of the total 7 species identified from Lokhra area, 3 belonged to Eribidae, 2 to Geometridae, 1 to Noctuoidae and 1 to Crambidae.

The diversity and species richness indices calculated were Shannon Weiner diversity index, Simpson's index, Margalef richness index and Pielou's evenness index (Table 2). The Shannon Weiner diversity index were found to be 2.47, 2.133 and 1.89 in Hatigaon, Noonmati and Lokhra areas, respectively. The Simpson diversity index, which represents species diversity within a community, was calculated at 0.092, 0.134 and 0.153 in Hatigaon, Noonmati and Lokhra, respectively. The Margalef index was highest for Hatigaon (3.0397), followed by Noonmati (2.37) and Lokhra (1.518). Pielou Index was 1.0, 0.96 and 0.85 in Hatigaon, Noonmati and Lokhra, respectively. All calculated values show significant differences within the study areas and a comparative analysis was performed for better appraisal of the data (Fig. 3).

## Discussion

The study was conducted in three urban areas within the Guwahati City. Among all moth species identified, the highest diversity in terms of percentage was found in Noonmati area, which may be attributed to the presence of the Amsing reserve forest within a 4 km radius. Furthermore, in Lokhra the diversity index was 1.89, which may be attributed to the nearest Garbhanga Reserve Forest. On the other hand, the central Hatigaon area, even though delivered 14 species, presented a lower diversity index, which may be attributed to the loss of moth habitat due to human settlements. The Simpson diversity index that represents species diversity within a community, was highest in Hatigaon area, despite the uniform species diversity in the habitat. The Margalef index of species diversity divides diversity into two components: species richness (the number of species present) and species evenness or dominance (how individuals are distributed among species within a community). This index was also found highest in Hatigaon, at 3.0397, followed by Noonmati area, at 2.37 and Lokhora at 1.518. The species of the family Geometridae, with relatively abundance of 28.12%, may be considered as potent indicator species and can be studied long-term as indicative of environmental changes. The study anticipates to establish moth assemblage as a surrogate for the entire insect community and moths may be used as indicator taxa in rapid habitat-quality assessment programs for conservation and management of biological systems. Moths tend to 'bridge the gap' in practical conservation considerations, as they allow a constructive focus ranging from single target species to assemblage diversity and its patterns in relation to land use and disturbance (Uniyal et al., 2016). In times when there is urgent need for resources and time for biodiversity conservation, rapid methods of assessing biogeographic details are gaining momentum. The use of biological indicators for species richness, is a method which assumes that the species richness of well-known and lesser-known groups is correlated (Hughes et al. 2010). Monitoring invertebrates has also

Table 2. Species diversity and richness indices of all the study areas within the city.

| | | **Shannon-Wiener Index ($H' = -\Sigma$ Pi ln Pi)** | **Simpson's Index ($D = \Sigma$ (Pi)2)** | **Margalef index (D = S-1/ ln(N))** | **Pielou Index (E= H ln (S))** |
|---|---|---|---|---|---|
| Sl No. | City Area | Value | Value | Value | Value |
| 1 | Hatigaon | 2.470 | 0.093 | 3.040 | 1 |
| 2 | Noonmati | 2.133 | 0.134 | 2.378 | 0.96 |
| 3 | Lokhra | 1.899 | 0.153 | 1.518 | 0.85 |

 


FIG. 3: Moth species recorded during the study. 1. *Alypia octomaculata* 2. *Udea rubigalis* 3. *Eugoa basipuncta* 4. *Elophila gyralis* 5. *Pygospila tyres* 6. *El. obliteralis* 7. *Euproctis chrysorrhoea* 8. *Syntomoides imaon* 9. *Acronicta rumicis* 10. *Pyralis farinalis* 11. *Halysidota tessellaris* 12. *Olepa ocellifera* 13. *Elophila* sp. 14. *Tineola bisselliella* 15. *Agathia lycaenaria* 16. *Pelagodes antiquadraria* 17. *Tanaorhinus dimissa* 18. *Dysphania militaris* 19. *Hemithea graminea* 20. *Sphrageidus similis* 21. *Hypodoxa muscosaria* 22. *Platyptilia carduidactyla* 23. *Amata phegea* 24. *Sphenarches anisodactylus* 25. *Ostrinia nubilalis* 26. *Manduca rustica* 27. *Synchlora aerate*.

 

become a worldwide priority because of their ecosystem services (Rohr et al. 2015). Despite the gradual transitions and short distances between the various habitat types studied, each habitat provided sufficient resources to support its own characteristic moth populations. The observed changes in diversity and species-richness patterns can therefore be attributed to extensive urbanization, anthropogenic interventions, and habitat destruction in and around Guwahati over the past few decades.

## Conclusion

This study examines the impact of urbanization on moth diversity and species richness in Guwahati, the largest city in Northeast India, focusing on three urban areas: Hatigaon, Noonmati, and Lokhra. Moths, belonging to the order Lepidoptera, are valuable bioindicators due to their sensitivity to environmental changes, making them useful for detecting ecological disturbances. During the survey, a total of 168 moths were recorded across the selected sites. Diversity was assessed using multiple indices. The Shannon–Wiener index, which measures species diversity, was highest in Hatigaon, followed by Noonmati and Lokhra. The Simpson diversity index showed values of 0.092 for Hatigaon, 0.134 for Noonmati, and 0.153 for Lokhra, reflecting differences in community composition. Margalef's index of species richness was also highest in Hatigaon, suggesting greater species diversity, followed by Noonmati and Lokhra. Among the nine families recorded, Geometridae was relatively abundant and is highlighted as a strong indicator for long-term environmental monitoring. The study underscores the relationship between species richness in both well-known and lesser-known groups, emphasizing the local and global significance of monitoring invertebrates for sustaining ecosystem services.

## Author Contributions

DJH: Conceptualization; Supervision; Data curation; Formal analysis.
IH: Supervision; Validation; Review & editing.
ND: Investigation; Data curation; Formal analysis; original draft.
LB: Data curation; Formal analysis; Review & editing.

## Acknowledgements

The authors acknowledge the financial assistance from the Department of Science and Technology (DST), Govt. of India, under DST-CURIE (WISE KIRAN Division) scheme for women P.G. Colleges (Ref. No. DST/CURIE-PG/2022/88(G)) and the Department of Zoology, Handique Girls' College, Guwahati. Assam, India, for the laboratory facilities.

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