



Diversity and Distribution of Moths (Lepidoptera: Heterocera) from Osmanabad Districts, Maharashtra

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Abstract-

The present study was conducted at the across Osmanabad district. Study compiled as baseline contribution to diversity and distribution of moths in the Osmanabad district, Population status of moth, a species richness, abundance and evenness. Selected site was surveyed from Jan- 2022 - December 2023. 18 species of Moths were yield as a result of present study. that Noctuidae is most diverse family and having 8 species i.e. *Spodoptera exigua*, *Spodoptera litura*, *Mythimna separata*, *Helicoverpa armigera*, *Chrysodeixis eriosoma*, *Thysanoplusia orichalcea*, *Agrotis ipsilon*, *Agrotis segetum* after which Erebiidae having 03 species i.e. *Achaea Janata*, *Aloa lactinea*, *Olene mendosa* and Sphingidae having 03 species i.e. *Agrius convolvuli*, *Daphnis nerii*, *Acherontia styx* are dominating families recorded from the area, 01 species is recorded from each family i.e. Notodontidae, Crambidae Nolidae and Geometridae. *Netria multispinae*, *Maruca vitrata*, *Blenina donans*, *Agathia laetata* respectively.

They are also monitored to indicate climatic changes and environmental degradation. Occurrence and population of moth has greatly influenced by environment that includes rainfall and temperature. Diversity is one of the important cornerstones of sustainable development and represents the biological wealth of a given Nation. The survey enhanced understanding of the bio-diversity of Moths in Osmanabad districts and will be helpful in conducting further research and conservation operations. The diversity indices for moth fauna of this area have been calculated for the first time from the department of Zoology.

Keywords- Lepidoptera, Moth, Diversity, Similarity matrix.

Introduction

Order Lepidoptera is majorly stand for moths with 1,65,000 worldwide reported species or more and likely similar number of unreported species. Among which 12,000 species of moths have been represented by India. Moths are environmental indicators as they are well dispersing in different habitat, closely interact with the diverse vegetation and are responsive to environmental changes. Most of the vegetation are rely on many different moths' species for pollination. Reduction of the moth population and their diversity might lead adverse effect on the vegetations they pollinate. In order to develop a conservation strategy, a checklist of biodiversity is of primary significance as part of biodiversity conservation for viable development. They are also considered crucial for ecosystem services because they play numerous roles such as agricultural pests. Moths and their larvae are required as food for many other species, such as amphibians, bats, small mammals, and also bird species and indicators of ecological fitness. A recent study in Osmanabad listed 18 species of moths. The present study was contributed to understand distribution and diversity of moths in this region.

Osmanabad is one of administrative district of state Maharashtra. Most of the area is rocky, while remaining park is plain. Osmanabad weather forecast providing a local hourly Osmanabad weather forecast of rain, sun, wind, humidity and temperature. Osmanabad is 629 m above sea level and Osmanabad district is located in southern part of state, located at 18.17° N 76.03° E. Most part of district surrounded by Balaghat range (Washi, Kalamb, Osmanabad, and Tuljapur Tahsil.) Some part of the major rivers like Godavari and Bhima flows through this district. Osmanabad district is surrounded by Solapur, Ahmednagar, Beed, Bidar and Gulbarga (Karnataka) districts.

Biodiversity of Osmanabad: -

The forest types are of the type of South tropical (regional) arid deciduous forests and thorny forests. Most of the forest area is hilly wooded land with patches of scrub land. The common trees found are Apta, Sag, Sandalwood, Guggul / Salai, Neem, Bhera, Garadi, Savar, Ain, Bor, Dhaman, Sitaphal, Saada, Moh, Medshing, Behda, Acacia catechu (Khair), Acacia leuco phloea (Hiwar), Acacia nilotica (Babul), Aegle marmelos (Bel), Albizzia lebbek, Albizzia procera, Anogeissus latifolia (Dhawda), Butea monosperma (Palas), Boswelliaserrata (Salaia), Ficus and Terminalia species. The common shrubs include Vites negundo, zizyphus species, Cassia auriculata (tarwad), Carissa carandas, and Helicteres isora (Murudsheng) and Ghaneri shrubs are also found in large numbers here. Apart from these, the forest department has planted a large number of trees like Bor, Shisam, Subabul, Glyricidia etc. The animals include Leopard, wild cat, striped Hyaena, Black Buck, Jackal, wolf, fox, monitor lizards, porcupine, Barking deer, Hares. More than 100 species of birds are recorded in the sanctuary area. The threats include Illicit cutting, forest fires, encroachment, hunting and tress passing. The spread of shrubby weed Lantana camara is causing damage to the grasslands. The animals in the sanctuary face water scarcity during summer.

Materials and Methodology

Sampling was conducted using a mercury vapour lamp (Philips HQL 125W) and light traps across 52 trap-nights (≈ 4 h per night). Weather and phenology are known to influence nightly moth activity and light-trap catches (Intachat et al., 2001; Jonason et al., 2014), so the observed patterns should be interpreted in light of these factors.

Study Area

The study was conducted across eight talukas of Osmanabad district, Maharashtra (India): Paranda, Bhoom, Washi, Tuljapur, Omerga, Lohara, Osmanabad, and Kalamb. The district is marked for seasonal variation in rainfall and temperature. The vegetation comprises dry deciduous forests, scrublands, and agricultural landscapes, providing a mosaic of habitats favorable for moth communities. Sampling was carried out from January 2022 to December 2023, covering two full annual cycles to incorporate seasonal variation in moth abundance and diversity (Danks, 2007; Intachat et al., 2001).

Sampling Technique

Light Traps: Moths were sampled using a mercury vapour lamp (Philips HQL 125 W) connected to a white sheet setup, which was operated for ~ 4 hours per night.

Trap Nights: A total of 52 trap nights were conducted across all talukas, ensuring comparable sampling effort. Attraction Methodology, Light-trap sampling is one of the most reliable methods for nocturnal

Lepidoptera, though it is influenced by trap radius, weather, and seasonality (Beck & Linsenmair, 2006; Jonason et al., 2014).

Specimen Handling and Identification

Moths attracted to the light were collected using insect nets and transferred to killing bottles charged with ethyl acetate. Specimens were later pinned, spread, and preserved following standard entomological protocols (Shields & Heinbockel, 2006). Identification was carried out using available taxonomic keys and reference collections, supplemented by online databases (GBIF Secretariat, 2019; Goff, 2008). Specimens were identified up to species level wherever possible; in total, all 18 specimens were successfully identified to species level. Family- and subfamily-level classification followed Kristensen & Skalski (1999); Kristensen et al. (2007).

Data Analysis

Species Richness: The total number of species per taluka was recorded to evaluate relative diversity.

Family Composition: The representation of different families and subfamilies was tabulated. **Pairwise Species Overlap;** The number of species shared between each pair of talukas was calculated to assess community similarity.

Similarity Indices; Percentage similarity between talukas was computed (likely Sørensen or Jaccard index) to reveal ecological clusters (Kerr et al., 2000; Kadlec et al., 2009).

Interpretation: The patterns were compared with published literature to contextualize the findings (Fox, 2013; Newbold et al., 2015).

Methodological Considerations

Weather Influence: Moth activity is strongly influenced by temperature, humidity, and moonlight intensity, affecting light-trap catches (Intachat et al., 2001; Jonason et al., 2014).

Sampling Bias: Although light traps are highly effective, they are more selective for certain families (e.g., Noctuidae, Sphingidae), which may explain their dominance in the results (Beck & Linsenmair, 2006).

Seasonality: Seasonal peaks in diversity are expected, especially during post-monsoon months when vegetation and host plants are abundant (Sanyal et al., 2013).

Table 1- Checklist of moths from Osmanabad Maharashtra.

Sr.No.	Scientific Name	Family
1	<i>Spodoptera exigua</i>	Noctuidae
2	<i>Spodoptera litura</i>	Noctuidae
3	<i>Mythimna separata</i>	Noctuidae
4	<i>Helicoverpa armigera</i>	Noctuidae
5	<i>Chrysodeixis eriosoma</i>	Noctuidae
6	<i>Thysanoplusia orichalcea</i>	Noctuidae
7	<i>Agrotis ipsilon</i>	Noctuidae
8	<i>Agrotis segetum</i>	Noctuidae
9	<i>Netria multispinae</i>	Notodontidae
10	<i>Maruca vitrata</i>	Crambidae
11	<i>Achaea janata</i>	Erebidae
12	<i>Aloa lactinea</i>	Erebidae
13	<i>Olene mendosa</i>	Erebidae
14	<i>Blenina donans</i>	Nolidae

15	<i>Agathia laetata</i>	Geometridae
16	<i>Agrius convolvuli</i>	Sphingidae
17	<i>Daphnis nerii</i>	Sphingidae
18	<i>Acherontia styx</i>	Sphingidae

Results: -

Table 2-Number of moth species recorded within talukas of Osmanabad district.

Sr. No.	Talukas	No. of species recorded
1.	Paranda	13
2.	Bhoom	13
3.	Washi	16
4.	Tuljapur	17
5.	Omerga	12
6.	Lohara	12
7.	Osmanabad	16
8.	Kalamb	12

In Osmanabad district, the number of species recorded varies across different talukas. The highest number of species was recorded in Tuljapur (17 species), followed closely by Washi and Osmanabad (16 species each). Paranda and Bhoom each recorded 13 species, while Omerga, Lohara, and Kalamb showed the lowest richness with 12 species each.

Table 3-Data illustration for taxon's recorded from study area.

Sr. No.	Family	Number of Subfamily	Total Identified Specimens	Identification of specimens up to	
				Genus	Species
1.	Noctuidae	03	08	07	08
2.	Notodontidae	01	01	01	01
3.	Crambidae	01	01	01	01
4.	Erebidae	03	03	03	03
5.	Nolidae	01	01	01	01
6.	Geometridae	01	01	01	01
7.	Sphingidae	02	03	03	03
Total	07	12	18	17	18

A total of 18 moth specimens belonging to 7 families were recorded. Among these, 12 subfamilies were identified. Out of 18 specimens, 17 were identified up to genus level, and all 18 were identified up to species level.

Family Noctuidae was the most dominant, represented by 3 subfamilies and 8 specimens, all of which were identified up to species level. Sphingidae was the second most diverse family with 2 subfamilies and 3 specimens, also completely identified up to species level. Erebidae comprised 3 subfamilies with 3 specimens, all identified to species level. Other families such as Notodontidae, Crambidae, Nolidae, and Geometridae were represented by only 1 specimen each, but all were successfully identified to species.

Table 4-Common moth species (c) recorded within respective talukas for first year (1 January 2022 to 31 December 2023).

Talukas	Paranda	Bhoom	Washi	Tuljapur	Omerga	Lohara	Osmanabad	Kalamb
Paranda	*	13	11	12	12	11	11	11
Bhoom	*	*	11	12	12	11	11	11
Washi	*	*	*	16	11	11	16	11
Tuljapur	*	*	*	*	11	12	16	12
Omerga	*	*	*	*	*	11	10	11
Lohara	*	*	*	*	*	*	11	12
Osmanabad	*	*	*	*	*	*	*	11
Kalamb	*	*	*	*	*	*	*	*

The table represents the number of species shared between pairs of talukas in Osmanabad district. This type of data is often used to measure similarity or overlap in species composition, helping us understand ecological distribution and biodiversity patterns.

1. High Similarity Zones

The maximum species similarity (16 species) is observed between:

1. Washi and Tuljapur
2. Washi and Osmanabad
3. Tuljapur and Osmanabad

This indicates that these three talukas have very similar environmental conditions, habitats, or resource availability, supporting a common pool of species. Together, they form a biodiversity cluster.

2. Moderate Similarity

Paranda and Bhoom share 13 species, which shows that these two talukas are ecologically more similar to each other than to the others. Most other taluka pairs (e.g., Paranda with Tuljapur, Omerga with Bhoom, Kalamb with Lohara) share 11–12 species, suggesting moderate overlap.

3. Low Similarity

The least similarity (10 species) is recorded between Omerga and Osmanabad. This indicates that Omerga might have a somewhat different habitat type or unique ecological conditions, making its species composition relatively distinct.

4. Patterns and Ecological Implications

Cluster 1: Washi–Tuljapur–Osmanabad → Highly similar, possibly sharing similar vegetation, soil, or climate factors.

Cluster 2: Paranda–Bhoom → Moderately similar, forming a separate smaller group.

Outlier: Omerga → Lower similarity with most talukas, possibly due to geographic location, microclimatic differences, or habitat fragmentation.

Kalamb and Lohara show balanced similarity (11–12 species with others), acting as intermediate zones that share species with multiple clusters.

Discussion:

Present study aimed to record both macros as well as micro moth families; 18 moth species recorded belongs to 07 families. In the present survey in total 18 moth species were identified comprising 17 genera from 12 subfamilies belongs to 07 families recorded in Osmanabad districts. Out of 18 moth specimens 18 moths were identified up to species level and 17 moths identified up to generic level. Appendix 1 represents the systematic inventory of moth species with appearance of adults; their distribution within Osmanabad districts.

In the present survey moth species were recorded and species are represented by 07 families i.e. Noctuidae, Notodontidae, Crambidae, Erebidae, Nolidae, Geometridae and Sphingidae, out of these 07 families Noctuidae family is dominant family i.e. out of 18 species 8 species recorded from Noctuidae family, followed by Erebidae and Sphingidae. Out of 18 species 03 species are belonging to Erebidae family and 03 species are belonging to Sphingidae family, 01 species is belonging to Notodontidae, 01 species is belonging to Crambidae, 01 species is belonging to Geometridae and 01 species is belonging to Nolidae family. So total 18 species recorded from Osmanabad districts.

In Noctuidae family total 08 species recorded out of them 02 species are belonging to subfamily Plussinae, 05 species are belonging to subfamily Noctuinae and 01 species is belonging to subfamily Heliothinae. In Notodontidae family 01 species is recorded which is belonging to subfamily Dudusinae. In Crambidae 01 species is belonging to subfamily Spilomelinae, in Erebidae family total 03 species recorded out of them each species is belongs to different subfamily i.e. Achaea Janata is belonging to Erebininae, Aloa lactinea is belongs to Arctiinae and Olene mendosa is belongs to Lymantriinae. In Nolidae Blenina donans is belongs to subfamily Blenininae. In Geometridae family Agathia laetata is belonging to subfamily Geometrinae, in Sphingidae family 03 species are recorded out of them 02 species are belonging to subfamily Sphinginae and 01 species is belonging to subfamily Macroglossinae.

Table 5 - Similarity Matrix for respective talukas for first year (1 January 2022 to 31 December 2023).

Talukas	Paranda	Bhoom	Washi	Tuljapur	Omerga	Lohara	Osmanabad	Kalamb
Paranda	*	89.92	75.2	73.57	84.753	82.404	76.699	85.584
Bhoom	*	*	76.8	75.5687	88.433	83.114	76.7283	87.471
Washi	*	*	*	90.7801	73.072	80.855	90.7343	79.598
Tuljapur	*	*	*	*	75.0266	79.5699	91.3884	78.8675
Omerga	*	*	*	*	*	86.9359	74.6082	87.8713
Lohara	*	*	*	*	*	*	80.6545	89.4382
Osmanabad	*	*	*	*	*	*	*	79.005
Kalamb	*	*	*	*	*	*	*	*

1. High Similarities (> 90%)

Tuljapur – Osmanabad (91.38%) → Highest similarity recorded in the dataset.

Washi – Tuljapur (90.78%) and Washi – Osmanabad (90.73%) → Very high overlap. This confirms that Tuljapur, Washi, and Osmanabad form the strongest biodiversity cluster, indicating almost identical species composition across them.

2. Moderately High Similarities (85–90%)

Omerga – Kalamb (87.87%)

Bhoom – Kalamb (87.47%)

Lohara – Kalamb (89.43%)

Paranda – Kalamb (85.58%)

Omerga – Bhoom (88.43%)

Kalamb shows strong similarity with multiple talukas, acting like a bridge zone. Bhoom and Omerga also show high similarity, suggesting they share a comparable species pool.

3. Moderate Similarities (75–85%)

- Paranda – Omerga (84.75%)
- Paranda – Lohara (82.40%)
- Bhoom – Lohara (83.11%)
- Washi – Lohara (80.85%)
- Tuljapur – Lohara (79.56%)
- Osmanabad – Lohara (80.65%)

These indicate moderate ecological resemblance, but not as strong as the >90% clusters.

4. Lowest Similarities (< 75%)

- Washi – Omerga (73.07%)
- Tuljapur – Omerga (75.02%)
- Paranda – Tuljapur (73.57%)
- Washi – Paranda (75.29%)

These combinations show lower overlap, meaning Omerga and Paranda have slightly distinct habitats or environmental conditions compared to Washi/Tuljapur.

Ecological Patterns Identified

1. Core Cluster (very high similarity) → Tuljapur, Washi, Osmanabad
These talukas share >90% similarity, forming the biodiversity hub of the region.
2. Kalamb as a Connector
Kalamb shares 85–89% similarity with almost all talukas, acting as an intermediate ecological bridge.
3. Secondary Cluster
Bhoom and Omerga show strong similarity (88.43%), suggesting another grouping.
4. Distinct Talukas
Paranda has relatively lower similarity with Washi and Tuljapur ($\approx 73\%$), indicating slight ecological uniqueness. Omerga also shows lower similarity with Washi and Tuljapur, suggesting different ecological/vegetation conditions.

Conclusion:

The study emphasizes that moth diversity in Osmanabad district is heterogeneously distributed, with Tuljapur, Washi, and Osmanabad acting as biodiversity hotspots, while Omerga and Paranda represent ecologically distinct habitats. Noctuidae emerged as the dominant family, reflecting broader global patterns of Lepidoptera diversity. The similarity analysis revealed two distinct biodiversity clusters with Kalamb functioning as an ecological bridge. These findings not only contribute to baseline data for regional biodiversity but also provide valuable insights for habitat-specific conservation strategies.

1. Species Richness across Talukas

Across eight talukas, species richness varied from 12–17 species. Tuljapur recorded the highest richness (17 species), followed by Washi and Osmanabad (16 species each), while Paranda and Bhoom recorded 13 species, and Omerga, Lohara, and Kalamb recorded 12 species each. Variation in richness across short geographic distances can be driven by vegetation structure, topography and microclimate, and land-use differences, which are known to shape moth assemblages (Highland et al., 2013; Sanyal et al., 2013; Newbold et al., 2015).

2. Family and Subfamily Representation

A total of 18 specimens were identified, belonging to 7 families and 12 subfamilies. Noctuidae was the most dominant family (8 species, across 3 subfamilies), followed by Erebidae (3 species, 3 subfamilies) and Sphingidae (3 species, 2 subfamilies); Notodontidae, Crambidae, Geometridae, and Nolidae were each represented by one species. Dominance of Noctuidae is consistent with broader Lepidoptera systematics and global patterns of moth diversity (Kristensen et al., 2007; Goldstein, 2017), and with the known efficiency and selectivity of light-trap sampling for many noctuid and sphingid taxa (Beck & Linsenmair, 2006; Jonason et al., 2014).

3. Shared Species between Talukas

The highest overlap (16 shared species) occurred among Washi–Tuljapur–Osmanabad, indicating a core biodiversity hub with near-identical assemblages. Paranda–Bhoom showed comparatively high overlap (13 species). The lowest overlap (10 species) was between Omerga and Osmanabad. Such clustering and separation patterns are expected when local habitat structure and land-use regimes differ (Kadlec et al., 2009; Intachat et al., 2001; Broadbent et al., 2012; Garcia-Vega & Newbold, 2020).

4. Similarity Index (Percentage Data)

Similarity analysis reinforced these relationships: Tuljapur–Osmanabad (91.38%), Washi–Tuljapur (90.78%), and Washi–Osmanabad (90.73%) formed the strongest cluster; Bhoom–Omerga (88.43%), Kalamb–Lohara (89.43%), and Omerga–Kalamb (87.87%) indicated a secondary grouping with Kalamb acting as a bridge. Lower similarities (≈ 73 –76%) for Paranda–Tuljapur and Washi–Omerga reflect ecological distinctness likely linked to differing vegetation mosaics and microclimates (Kadlec et al., 2009; Newbold et al., 2015; Garcia-Vega & Newbold, 2020).

This shows two distinct biodiversity clusters:

1. Cluster 1 (Core Biodiversity Hub): Tuljapur–Washi–Osmanabad
Extremely high overlap, indicating very similar environmental conditions.
2. Cluster 2 (Secondary Group): Bhoom–Omerga–Paranda–Lohara
High internal similarity, forming a separate grouping.

Kalamb appears as a bridge taluka, showing high similarity with both clusters.

5. Ecological Implications

The clustering suggests that central talukas (Tuljapur, Washi, Osmanabad) are more ecologically uniform, possibly due to shared vegetation, soil type, or climatic conditions. Peripheral talukas (Bhoom, Paranda, Omerga, Lohara) show different but internally consistent species pools, likely influenced by local habitat variation. Kalam's bridging role may be due to its transitional habitats, supporting species from both clusters. Omerga and Paranda consistently show lower similarity with the biodiversity hub, highlighting their ecological distinctiveness and potential conservation importance.

A future course of action:

Inventorying is the first step in conservation. The list of moths presented here is preliminary, considering the rich faunal diversity of the area; a more comprehensive study is required to document the entire biodiversity present in this area. A detailed survey will be carried out to record the moth fauna of this area with proper scientific documentation. This exhaustive survey of all regions will be conducted using the additional sampling methods noted above.

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