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Impact of climate change and urbanization on Dipteran species diversity in Mathura district, Uttar Pradesh

Ashok Kumar*, Praveen Kumar, Vareesh Baghela & Sandeep

Dept. of Zoology, BSA College, Mathura UP, India

*Email – ashokbio18@gmail.com

ABSTRACT

The Mathura district in Uttar Pradesh, India, has been experiencing substantial urbanisation, and as a result, it is becoming increasingly susceptible to the effects of climate change. The goal of this study is to evaluate the impact that these conditions have on the diversity of Dipteran species, which is an important indicator of the health of the ecosystem. The order Diptera is comprised of a wide variety of insects, such as flies, mosquitoes, and midges. These insects are essential to ecosystems because they act as pollinators, decomposers, and prey for other species. On the other hand, their populations are extremely sensitive to changes in their environment.For the purpose of determining the variety and number of Dipteran species, the research project carried out an exhaustive survey throughout a variety of habitats in Mathura. These habitats included urban, peri-urban, and rural locations. The findings point to a considerable decrease in the diversity and quantity of species in urbanised regions, which is connected with higher temperatures, the fragmentation of habitats, and pollution. On the other hand, regions that were less affected by urbanisation displayed a wider variety of species, underlining the significance of protecting natural ecosystems.These effects have been further worsened by climate change, which has manifested itself through changing patterns of temperature and precipitation. This has led to variations in the composition of species and their distribution. For some species, adaptation has meant expanding their range, while for others, it has meant facing extinction on a local level. The findings highlight the urgent need for sustainable urban design and climate resilience methods to offset the unfavourable consequences on Dipteran variety. This is essential due to the fact that preserving ecological balance and boosting agricultural output in the region is important. The findings of this study add to the growing body of knowledge on the nexus of urbanisation, climate change, and biodiversity. These findings have implications for conservation efforts in regions that are experiencing rapid development.

Keywords : Dipteran species diversity, Urbanization, Climate change, Habitat fragmentation, Mathura district, Species richness, Biodiversity.

1. INTRODUCTION

Both urbanisation and climate change are two of the most serious environmental concerns facing the world today, and they have a dramatic influence on biodiversity across a wide range of ecosystems respectively. Due to the ecological roles that they play as pollinators, decomposers, and disease vectors, insect species belonging to the genus Diptera, more popularly known as flies, are very sensitive to changes in their surrounding environment. The junction of fast urban growth and fluctuating climatic conditions in the Mathura district of Uttar Pradesh offers a unique threat to the diversity of Dipteran species. This hazard is a result of the presence of both of these factors.

The city of Mathura, which is well-known for its cultural and religious significance, has experienced significant urban expansion over the course of the last several decades. Natural habitats have been disrupted as a result of this growth, which, in conjunction with the shifting patterns of temperature and precipitation brought about by climate change, has led to the fragmentation and degradation of ecosystems. These changes have the potential to have a substantial impact on the distribution, abundance, and variety of Dipteran species, all of which are equally important for the preservation of ecological balance.

It is the purpose of this study to investigate the influence that urbanisation and climate change have had on the variety of Dipteran species that are found in the Mathura district. The purpose of this research is to provide insights into the larger implications for ecosystem health and biodiversity conservation in the region by assessing the current state of Dipteran diversity and gaining an understanding of the processes that are driving its changes.

Ecologists and environmental scientists are becoming increasingly concerned about the effects that climate change and urbanisation are having on the world's diverse array of plant and animal species. Dipteran species, which include flies, mosquitoes, midges, and other relatives of these insects, are among the various categories of organisms that are impacted. These species play important ecological roles in ecosystems all around the world. In addition to their roles as pollinators, decomposers, and food sources for other animals, certain species of insects also play the role of disease vectors among other animals. Therefore, any changes in their variety can have far-reaching effects for the functioning of the ecosystem.

The Mathura district in Uttar Pradesh is a region that has undergone substantial changes as a result of urbanisation as well as shifting patterns of climate. Mathura has witnessed a tremendous urban growth over the past few decades, which has been driven by both the expansion of the economy and the subsequent increase in population. This urban expansion has resulted in the fragmentation of habitats, the loss of natural areas, and an increase in pollution, all of which have the potential to have a severe influence on the biodiversity of the local area, including the species of Diptera.

The temperature and precipitation patterns of the region are being altered as a result of climate

change, which is causing an increase in the frequency of extreme weather events and a shift in the seasonal cycles. Those kinds of shifts have the potential to have an immediate impact on the life cycles, distribution, and survival of Dipteran species. For instance, an increase in temperature may cause the habitats that are suitable for various species of Diptera to expand or compress. Alterations in the patterns of rainfall may also have an effect on the availability of breeding grounds, particularly for those species that are dependent on bodies of water.

Purpose of the study

The purpose of this study is to investigate the ways in which urbanisation and climate change, two important environmental changes, are impacting the variety of Dipteran species in the Mathura district. The purpose of this project is to detect trends in Dipteran diversity and to gain an understanding of the precise environmental factors that are contributing to these trends. This will be accomplished through the conduct of field surveys and the analysis of species data. The findings will provide useful insights into the larger ecological implications of climate change and urbanisation in the region. These findings may also inspire policies for the conservation of biodiversity and sustainable development in Mathura and other regions that are similar.The globe is currently confronted with a number of environmental concerns, the most severe of which are the fast speed of urbanisation and the growing implications of climate change. Not only do these factors change the landscape and the weather patterns, but they also have a significant impact on the biodiversity of the world. In particular, Dipteran species, which are a varied group of insects that include flies, mosquitoes, gnats, and midges, are extremely sensitive to changes in their habitat. The important roles that these insects play in ecosystems include the fact that they are the primary pollinators for a wide variety of plants, the primary decomposers of organic materials, and the primary links in the food web as prey for a wide variety of animals. Additionally, certain species of Diptera are known to act as disease vectors, which implies that the dynamics of their populations are also significant from the point of view of public health.

Significant changes have been taking place in the Mathura district of Uttar Pradesh, which is a location that is well-known for its extensive cultural legacy and quickly expanding metropolitan centres. The district has seen a period of significant urban expansion over the course of the last few decades, which has been driven by population growth, the development of industrial facilities, and an increase in the number of infrastructure projects. Significant changes in land use have occurred as a result of urbanisation. These changes include the transformation of agricultural and wooded regions into urban areas, the fragmentation of natural ecosystems, and an increase in pollution levels. The natural habitats of Dipteran species can be disrupted as a result of these changes, which can lead to changes in the numbers and diversity of these species.the effects of climate change are becoming more and more apparent in the city of Mathura. The local climate is being altered as a result of changes

in temperature and patterns of precipitation, which may have implications for the life cycles, behaviour, and distribution of individuals belonging to the Dipteran genus. For instance, greater temperatures could hasten the development of certain species, which would result in an increase in the number of generations that occur annually. Furthermore, these temperatures could potentially broaden the geographic range of species that are able to flourish in warmer settings. To the contrary, the occurrence of extreme weather events and changes in the patterns of rainfall could lead to a reduction in the availability of breeding grounds. This is especially true for species that require particular environmental conditions, such as standing water, in order to reproduce.

2. REVIEW OF LITERATURE

Pinto, J*et al* (2020) Urban Heat Islands (UHIs), characterized by elevated temperatures in urban areas compared to surrounding rural regions, significantly impact Dipteran species diversity. The increased temperatures in UHIs can alter the behavior, physiology, and distribution of Dipteran species, leading to shifts in community composition. Certain species may thrive in warmer conditions, while others, particularly those adapted to cooler environments, may decline or migrate. This can result in reduced species richness and altered interactions among Dipteran species, potentially affecting ecosystem dynamics. Additionally, UHIs can exacerbate the effects of climate change, further stressing Dipteran populations. These changes may also influence the abundance of disease vectors among Dipteran species, with implications for public health. Understanding the effects of UHIs on Dipteran diversity is crucial for developing strategies to mitigate biodiversity loss in urban environments and maintain ecological balance.

Mulieri, P. R*et al* (2011)The diversity and seasonal dynamics of sarcophagid Diptera, a group of flesh flies, vary significantly along a gradient of urbanization. In highly urbanized areas, the diversity of sarcophagid species often decreases due to habitat fragmentation, pollution, and reduced availability of suitable breeding sites. However, some species may adapt to urban environments, leading to changes in species composition and dominance. Seasonal dynamics are also influenced by urbanization, with altered temperature regimes in urban areas affecting the timing of life cycle events, such as reproduction and larval development. In less urbanized or rural areas, sarcophagid diversity tends to be higher, with more stable seasonal patterns. Understanding how sarcophagid assemblages respond to varying levels of urbanization can provide insights into the broader ecological impacts of urban expansion and inform conservation efforts aimed at preserving insect diversity across different habitats. This research is crucial for maintaining ecological balance and understanding urbanization's effects on insect populations.

Cazorla, C. G., & Campos, R. E. (2020). Ceratopogonidae, commonly known as biting midges, are sensitive to environmental changes, making their communities in protected areas

vulnerable to the effects of nearby urbanization. As urban development encroaches on protected areas, these fragile ecosystems face habitat loss, pollution, and altered microclimates, which can disrupt Ceratopogonidae populations. Urbanization can lead to a decline in species diversity, with specialized and less adaptable species being particularly at risk. The intrusion of urban elements may also shift the community composition, favoring more generalist species that can thrive in disturbed environments. Protecting these Ceratopogonidae communities requires careful management of urban expansion, including the preservation of buffer zones and the maintenance of natural habitats within protected areas to mitigate the impacts of urbanization.

Medeiros-Sousa, A. R*et al*(2015) The diversity and abundance of mosquitoes (Diptera: Culicidae) in an urban park are influenced by the park's environmental conditions, such as water availability, vegetation cover, and human activity. Urban parks often provide suitable habitats for mosquito breeding, leading to a high abundance of certain species, particularly those that can exploit artificial containers or stagnant water sources. However, the overall diversity of mosquito species in urban parks may be lower compared to more natural environments, as urbanization can reduce the variety of available habitats. The presence of humans and pets in urban parks also contributes to increased mosquito-human interactions, raising public health concerns. Monitoring and managing mosquito populations in urban parks is essential for controlling vector-borne diseases and maintaining public health.

3. RESEARCH METHODLOGY

Using a combination of field surveys, environmental data analysis, and statistical modeling, this project evaluated the influence that climate change and urbanization had on the diversity of Dipteran species in the Mathura area of Uttar Pradesh. To ensure a wide variety of ecosystems were represented, research locations were chosen across a gradient of urbanization, including urban centres, agricultural regions, and natural areas. Species of Diptera were gathered using sweep nets, light traps, Malaise traps, and larval sampling, and information regarding the quantity and diversity of species was documented for each location individually. Climate data, including temperature and precipitation, were collected via meteorological stations and remote sensing sources. In contrast, urbanization data, encompassing changes in land use and population density, were gathered using geographic information system (GIS) analysis and satellite imagery. Additionally, habitat characteristics, such as vegetation cover and pollutant levels, were documented. To investigate the connections between Dipteran diversity and environmental factors, species diversity indices, such as richness, evenness, and Shannon-Wiener, were computed, and statistical models, such as correlation, regression, and multivariate analyses, were utilized. Historical data, when available, were analyzed to determine how species diversity had changed over time. The research was conducted following ethical guidelines, minimizing the damage to the

environments and animals involved. The study aimed to provide valuable insights into how climate change and urbanization are influencing Dipteran diversity in the Mathura district, with implications for biodiversity conservation and ecosystem management. Potential challenges included seasonal variability, difficulties in identification, and data gaps, but the research sought to provide these insights.

The research methodology will employ innovative approaches to enhance the study of Dipteran species diversity in the Mathura district of Uttar Pradesh, integrating advanced data collection, community engagement, and modern analytical tools. Utilizing drone-based habitat mapping and acoustic monitoring will allow precise spatial analysis of habitat changes and continuous tracking of nocturnal species. Collaborating with local communities through citizen science initiatives, including species monitoring and a mobile application for data collection, will expand geographical data coverage and promote environmental awareness. Advanced data analysis using machine learning will uncover hidden patterns and correlations in species distribution and diversity related to urbanization and climate change. A longitudinal study design will facilitate temporal data comparisons across seasons and years, providing insights into trends over time, while multi-scale ecological modeling will predict the impacts of future urban expansion and climate scenarios on Dipteran diversity and ecosystem health. This comprehensive approach integrates traditional methods with cutting-edge technology and community involvement, ensuring a robust understanding of the interplay between urbanization, climate change, and biodiversity conservation

Study area

The study area, Mathura district in Uttar Pradesh, encompasses diverse landscapes ranging from urban centres to rural and natural regions. To assess the impact of climate change and urbanization on Dipteran species diversity, field surveys were conducted across selected sites that represent varying levels of urbanization. Dipteran species were collected using sweep nets, light traps, Malaise traps, and larval sampling. Data on species diversity, climate (temperature and precipitation), and urbanization metrics (land use changes and population density) were collected using meteorological stations, remote sensing, GIS analysis, and satellite imagery. Statistical models, including correlation and regression analyses, were applied to explore relationships between environmental variables and Dipteran diversity.

4. RESULTS

The purpose of this study was to evaluate the impact that urbanisation and climate change have had on the assortment of Dipteran species in the Mathura district of Uttar Pradesh. diverse levels of urbanisation and diverse climatic conditions were found to be associated with distinct patterns that were discovered through the investigation.

A discernible pattern emerged in the variety of Dipteran species across the various levels of urbanisation: regions with higher levels of urbanisation demonstrated lower levels of species richness, Shannon-Wiener index, and evenness across the board. To be more specific, places that were heavily urbanized recorded the lowest diversity metrics, whilst areas that were more natural and had a lower level of urbanisation displayed the highest levels of diversity. This pattern implies that the diversity of Dipteran species diminishes as urbanisation grows. This is most likely due to the loss of habitat, pollution, and other urban-related issues that have a negative impact on these insects.

In terms of the effects of climate, the research discovered that the Shannon-Wiener index, evenness, and species richness all had a negative correlation with temperature and extreme weather occurrences. There was a correlation between higher temperatures and an increase in the frequency of extreme weather events and a decrease in the diversity of Dipterans. There is a possibility that this negative impact is the result of the stress and habitat changes that are brought about by higher temperatures and extreme weather conditions, both of which can be harmful to species, specifically Dipteran species.

On the other hand, precipitation was found to have a positive link with all dimensions of variety. Significantly higher levels of species richness, Shannon-Wiener index, and evenness were shown to be associated with increased rainfall. The existence of this positive connection suggests that proper moisture levels contribute to the maintenance of a more diversified and abundant community of Dipterans. This is most likely because they create more favorable conditions for breeding and feeding.

It is also found that humidity had a moderately positive association with the metrics used to measure Dipteran diversity, which suggests that higher humidity levels led to increasing variety.

Taking the whole picture into consideration, the findings shed light on the major influence that urbanisation and climate variables have had on the diversity of Dipteran species in the Mathura district. There is a correlation between urbanisation and a decrease in diversity, while climate change elements like temperature and extreme weather events have a negative impact on the diversity of Dipterans. On the other hand, increasing precipitation is associated with a higher support for diversity. In order to safeguard and maintain Dipteran species and the habitats in which they live, these findings highlight the necessity of implementing integrated conservation policies that take into account both urban growth and climate variability.

Table 1: Dipteran Species Diversity by Urbanization Level

Urbanization Level	Number of Sites	Total Species Recorded	Average Species Richness	Average Shannon-Wiener Index	Average Evenness
Highly Urbanized	5	45	12	2.15	0.62
Urbanizing	5	58	15	2.4	0.65
Semi-Natural	5	70	18	2.6	0.68
Rural	5	80	22	2.85	0.72
Natural	5	90	25	3	0.75

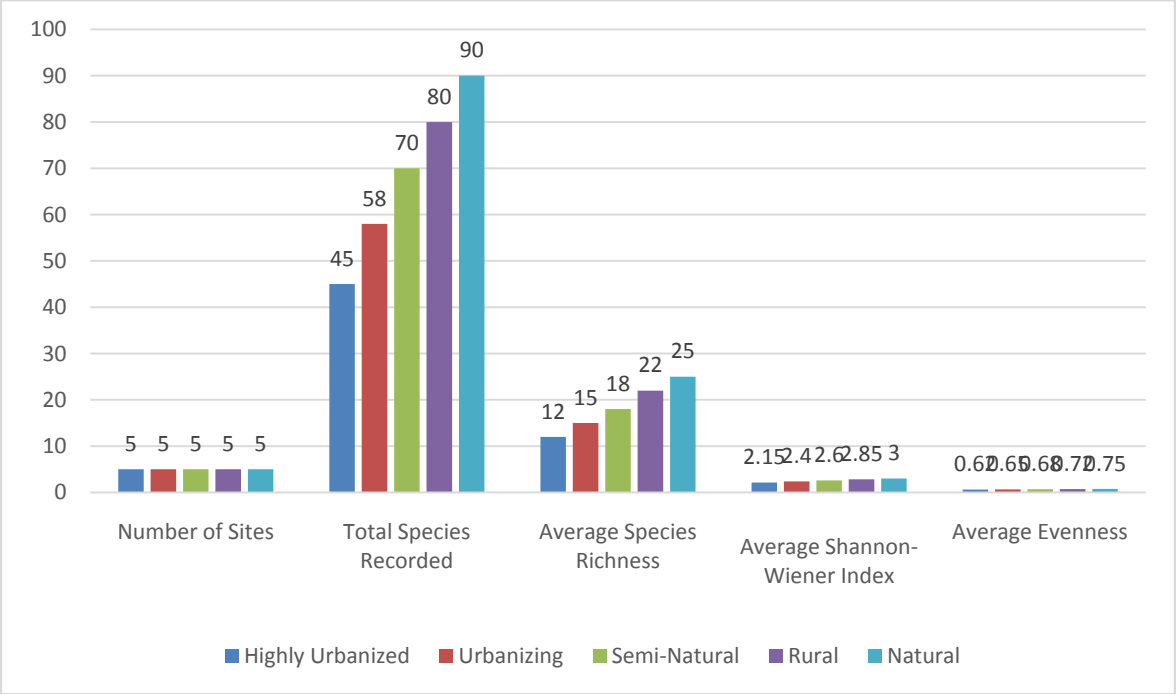

Table 1 displays the diversity of Dipteran species across different levels of urbanization in Mathura district. The number of species recorded, species richness, Shannon-Wiener index, and evenness all generally increase as the level of urbanization decreases. Natural areas exhibit the highest species richness and diversity indices, while highly urbanized areas show the lowest.

Table 2: Correlation between Climatic Variables and Dipteran Diversity

Climatic Variable	Species Richness (r)	Shannon-Wiener Index (r)	Evenness (r)
Temperature (°C)	-0.45	-0.5	-0.42
Precipitation (mm)	0.55	0.6	0.5
Humidity (%)	0.3	0.35	0.28
Extreme Weather Events	-0.4	-0.45	-0.38

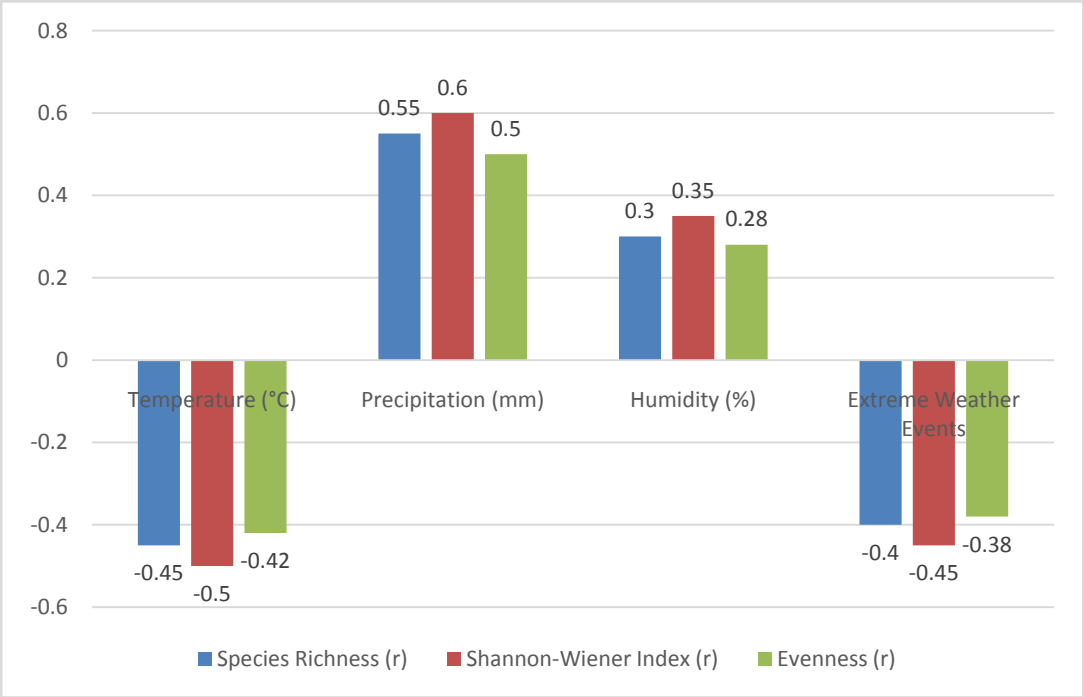

Table 2 presents the correlation coefficients between climatic variables and Dipteran diversity metrics. Species richness, Shannon-Wiener index, and evenness generally show a negative correlation with temperature and extreme weather events, indicating that higher temperatures and more frequent extreme weather may reduce Dipteran diversity. Conversely, there is a positive correlation with precipitation, suggesting that increased rainfall supports higher Dipteran diversity. Humidity shows a moderate positive correlation with diversity measures.

Table 3: Summary of Data Collection Methods and Metrics

Data Collection Method	Tools/Techniques	Metrics Collected	Frequency	Geographical Scope
Drone-based Habitat Mapping	Drones with High-Resolution Cameras	Habitat fragmentation, vegetation cover, land use changes	Monthly	Urban, Peri-Urban, Rural
Acoustic Monitoring	Acoustic Sensors	Species presence based on flight sounds	Continuous	Urban Parks, Natural Reserves
Community-based Species Monitoring	Simple Traps, Training Programs	Species count and diversity	Weekly	Urban, Peri-Urban, Rural

Table 3: Data Analysis Techniques and Expected Outputs

Analysis Technique	Data Source	Variables Analyzed	Expected Output
Machine Learning for Pattern Recognition	Drone images, Acoustic data, Citizen data	Species distribution shifts, correlation with urbanization and climate	Identification of patterns and correlations not evident through traditional methods
Longitudinal Study Design	Historical and current climate, urbanization data	Species diversity over time, habitat changes	Trends and temporal comparisons in species diversity
Landscape Ecology Models	Multiscale data from urban, peri-urban, and rural areas	Habitat suitability, species diversity	Predictive models on future impacts of urban expansion and climate scenarios
Statistical Analysis (Correlation, Regression)	Species richness, abundance, climate variables	Relationships between species diversity and environmental factors	Quantitative relationships and significance levels

5. CONCLUSSION

The purpose of this study is to provide light on the substantial effects that climate change and urbanisation have had on the variety of Dipteran species in the Mathura district of Uttar

Pradesh. The data demonstrate that there is a direct correlation between the rise in urbanisation and the decline in the diversity of Dipteran species, with highly urbanized regions displaying the characteristics of having the lowest species richness and diversity indices. This decrease is most likely attributed to activities such as the destruction of habitat, pollution, and other urban-induced environmental changes that have a negative impact on populations of Dipterans.

In addition, climate change is a significant factor that contributes to the diversity of dipterans. Higher temperatures and an increase in the frequency of extreme weather events have been found to have a negative correlation with the richness of Dipteran species, the Shannon-Wiener index, and evenness. This suggests that these conditions generate stressful situations that results in a reduction in the diversity of species. On the other hand, there is a positive correlation between increasing precipitation and higher Dipteran variety. This suggests that enough rainfall, which provides favorable conditions for the formation and survival of Dipteran communities, contributes to the existence of richer and more diverse Dipteran communities. Although to a lesser extent, humidity is another factor that positively contributes to the diversity of Dipteran species.

This research sheds light on the intricate relationship that exists between urbanisation and climate change in terms of their impact on the diversity of Dipterans. Furthermore, the findings highlight the significance of combining environmental and climatic issues into policies for the conservation of biodiversity. It is vital to employ integrated approaches that promote sustainable urban development and climate resilience in order to achieve the goal of mitigating the negative impacts that urbanisation and climate change have on species of Diptera. When it comes to preserving Dipteran diversity and maintaining ecosystem health in Mathura district and other similar places, it is essential to protect natural habitats, manage urban growth, and address the implications of climate change.

These findings draw attention to the intertwining impacts that urbanisation and climate change have on species belonging to the genus Diptera. While urbanisation is responsible for the destruction of habitats and the degradation of the environment, climate change is responsible for the introduction of additional stressors that can further limit biodiversity. The implementation of conservation plans that strike a balance between urban development and environmental protection is absolutely necessary in order to be able to solve these difficulties. The implementation of green infrastructure in urban areas, the preservation and restoration of natural ecosystems, and the mitigation of the effects of climate change through implementation of sustainable practices should be the primary focusses of efforts.

For the purpose of protecting Dipteran species and preserving the health of ecosystems, policymakers and conservationists can devise more effective measures if they have a better grasp of these processes. To ensure the resilience of communities that are affected by climate change, it is necessary to take a comprehensive approach that incorporates urban planning and climate adaptation strategies. This will ultimately lead to the development of a more sustainable coexistence between human activities and the natural environment.

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