



# Impact of Urban Lighting on Insects: A Legal Perspective on Environmental Concerns

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## **Authors' contributions**

*This work was carried out in collaboration among all authors. Authors have equal contribution in bringing out this research work. All authors read and approved the final manuscript.*

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## **ABSTRACT**

Light pollution, a result of excessive and improperly directed artificial lighting, has become a major environmental issue that affects a wide range of habitats. The spread of industrialization and urbanisation leads to an increase in artificial light's incursion into natural habitats, which modifies the behaviours and ecological dynamics of creatures. Insects are so important to the functioning of ecosystems, the impacts of Artificial Light at Night on insect populations have received a lot of attention. Recognising the urgent need to address the adverse impacts of light pollution on vital insect populations, this study aims to explore the effect of artificial light on insect mortality. Every morning, dead insects were gathered. The insects were drawn to the light source that was circling it during the experiment, but they eventually lost their path and perished tragically. Increased insect mortality throws off feeding chains, pollination, nutrient cycles, and other crucial ecological activities. In order to prevent light pollution from having a negative influence on these vital insect populations, conservation methods must be specifically targeted. The increasing urban lighting

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exacerbates light pollution, significantly impacting insect populations. This paper examines the ecological consequences and the role of environmental law in mitigating these effects, advocating for stricter regulations and sustainable lighting practices to preserve biodiversity and ecological balance. Key international environmental laws addressing light pollution include the Convention on Biological Diversity (CBD) and the European Union's directives on environmental protection. These laws emphasize the need for sustainable urban lighting practices to protect biodiversity and mitigate the adverse effects on insect populations.

**Keywords:** Artificial light; biodiversity; conservation; ecology; sustainable lighting.

## 1. INTRODUCTION

The rapid increase in human population has prompted the creation of new human settlements, resulting in the transformation of pristine environments into urbanised ecosystems with increased levels of artificial lighting. These artificial lights display a range of characteristics, including differences in brightness, frequencies, and colour schemes. As a result, there is an increase in light pollution, which in turn makes these lights more alluring to insects. According to U.S. Patent 4808 [1], the employment of gadgets like "Light Traps" and "Pest Smashers" to get rid of pests has grown significantly. However, it is important to note that these light traps are unable to distinguish between pest species and the beneficial population of pollinators. Insect attraction to artificial light sources has increased due to the falling cost of lighting and improvements in the quantity and quality of artificial light installations globally [2]. Sadly, not much study has been done on how light pollution affects pollinator mortality, despite the fact that 87% of major food crops depend on animal pollinators to reproduce [3]. The global food security is seriously threatened by the disappearance of pollinators. Urban lighting, while essential for modern living, has inadvertently contributed to a rise in light pollution, significantly impacting insect populations. Insects play crucial roles in ecosystems, including pollination, nutrient cycling, and serving as food sources for other wildlife. However, the proliferation of artificial lighting disrupts their natural behaviors, leading to declining populations and biodiversity loss [4].

International environmental laws and agreements provide a framework to address these concerns. The Convention on Biological Diversity (CBD) emphasizes the importance of conserving biological diversity and encourages measures to mitigate factors, such as light pollution, that threaten ecosystems. Additionally, the European Union's directives on environmental protection

advocate for sustainable practices to reduce ecological impacts, including those from urban lighting [5].

Despite these provisions, the implementation and enforcement of regulations to combat light pollution remain inadequate. This paper examines the intersection of increased urban lighting and insect decline through an environmental law lens, advocating for stronger legal frameworks and sustainable lighting solutions to protect insect biodiversity and ensure ecological balance. The paper also throws light on various international and domestic laws and its perspectives [6].

## 2. MATERIALS AND METHODS

### 2.1 Sampling

We conducted our study on the collection of insect attracted to Artificial Light at Night using a doctrinal methodology. An empirical study made in variety of venues in Kolkata, West Bengal that has been included in our study. We collected data from ATM sites, hotels and other business buildings, and residential homes [7]. This survey was carried out in a daily basis. By taking into account the various metropolitan settings in which these insects were found, this approach helped us understand the patterns and effects of artificial light on insect mortality.

## 3. RESULTS AND DISCUSSION

Our analysis reveals a significant correlation between increased urban lighting and declining insect populations. Studies indicate that artificial lighting disrupts insect behaviour, reproduction, and survival rates [8]. The data shows a marked decrease in nocturnal insect activity and biodiversity in urbanized areas with high light pollution levels. The findings underscore the critical impact of urban lighting on insect populations, raising urgent environmental concerns. Current international laws, such as the

Convention on Biological Diversity (CBD) and European Union directives, provide frameworks for addressing light pollution [9]. However, implementation remains inconsistent. Strengthening these regulations and promoting sustainable lighting practices are imperative to mitigate the adverse effects. Enhanced public awareness and policy integration can foster compliance, ensuring ecological balance and biodiversity preservation. Future research should focus on innovative lighting technologies and urban planning strategies to reduce light pollution [10].

### 3.1 Trends in ATM

The quantity of insect corpses gathered in ATM. Day 7 saw the largest collection of corpses, totalling 59. The quantity of insect corpses generally decreases after Day 7 and reaches zero on Day 8. After that, the numbers begin to rise once more, fluctuating but never quite reaching Fig. 1's apex.

### 3.2 Trends in Commercial Place/Hotel

The number of insect corpses collected in commercial place/hotel is relatively stable, with some fluctuations. The highest number of corpses collected is on Day 7, but the numbers remain consistently higher than in ATM and house throughout the 30 days (Fig. 1).

### 3.3 Trends in House

The number of insect corpses collected in house also varies but is generally lower than in ATM and commercial place. The highest number of corpses collected is on Day 7, with 17 corpses. Unlike ATM, there is no day with zero corpses collected, but the numbers remain relatively low throughout the 30 days (Fig. 1).

### 3.4 Comparative Analysis

According to the findings, artificial light at night has a big influence on attracting insects, especially in the early stages. In commercial spaces, the quantities of insect corpses are more stable, but in ATMs, there is a discernible trend of decline following an initial high [11]. The house has the fewest insect carcasses, suggesting that artificial lighting within the house has less of an effect than lighting outside (Fig. 1).

**Indian Laws on Light Pollution and Environmental Protection:** India has several

laws and policies aimed at environmental protection, which can be applied to address the issue of increased urban lighting and its impact on insect populations. While there are no specific laws dedicated solely to light pollution, various existing regulations can be interpreted and enforced to mitigate its adverse effects [12].

#### 1. Environment (Protection) Act, 1986

The Environment (Protection) Act of 1986 is an overarching legislation providing a framework for the protection and improvement of the environment. Under this act, the government has the authority to set standards for emissions and discharges of pollutants, which can include light pollution.

#### 2. National Green Tribunal Act, 2010

The National Green Tribunal (NGT) Act established the NGT, which is responsible for the effective and expeditious disposal of cases relating to environmental protection and conservation of forests. The NGT can hear cases related to light pollution and its impact on biodiversity, including insects.

#### 3. Wildlife Protection Act, 1972

The Wildlife Protection Act aims to protect wildlife and their habitats. Excessive artificial lighting can disrupt the habitats of nocturnal insects and other wildlife. This act can be used to implement measures that reduce light pollution in protected areas.

#### 4. Biological Diversity Act, 2002

The Biological Diversity Act focuses on the conservation of biological diversity, sustainable use of its components, and fair and equitable sharing of the benefits arising out of the use of biological resources. Light pollution negatively affecting insect populations can be addressed under this act to ensure the conservation of biodiversity.

#### 5. Municipal Laws and Building Codes

Various municipal laws and building codes regulate urban development and infrastructure. These regulations can incorporate provisions for reducing light pollution, such as installing shielded lighting fixtures and promoting the use of energy-efficient lighting.

## 6. National Action Plan on Climate Change (NAPCC)

The NAPCC includes several missions that indirectly address light pollution, such as the National Mission for a Green India and the National Mission on Sustainable Habitat. These missions promote sustainable urban development practices, which can include strategies to reduce light pollution [13].

While India does not have specific legislation targeting light pollution, the existing environmental laws provide a framework for addressing the issue. Strengthening the enforcement of these laws and raising public awareness about the ecological impacts of artificial lighting can help mitigate the problem and protect insect biodiversity [14].



**Fig. 1. Number of dead insects collected in different sampling sites**

*(Source of Sample: Different places of Kolkata)*

## 3.5 Habitat Fragmentation Caused by Artificial Light at Night

Habitat fragmentation is a phenomena that occurs when sporadic light sources within previously intact ecosystems cause areas to be spatially partitioned into zones that receive and do not receive light. Anthropogenic lighting, which causes contiguous natural landscapes to fragment, is one of the contributing factors to this ecological disturbance caused by artificial light at night (ALAN). Wildlife mobility is restricted as a result of this fragmentation, which also disturbs their ecological niches and makes them less genetically diverse and more vulnerable to environmental shocks [15]. The complex effects of artificial night time light on wildlife in wild environments are presented in a thorough summary. ALAN exhibits a tendency to disturb reproductive dynamics, behavioural patterns, and survival strategies in a variety of animals. As such, it has the capacity to spread effects throughout complex ecosystems and jeopardise the stability of human food systems . Thus, in order to mitigate the detrimental effects of ALAN

on insect populations, it is necessary to promote efforts aimed at reducing light pollution and advocating for prudent outdoor lighting practices. Ecosystems are significantly impacted by light pollution, which disturbs the habitual activities of a wide range of species, including insects and animals. Their circadian cycles, or biological clocks, are also disturbed by this intervention. Nocturnal animals, or creatures that are mostly active at night, greatly depend on the cover of darkness for essential functions such food seeking, mating, and environmental navigation [16].

## 4. CONCLUSION

We have found a large study and observational gap in our current studies regarding the effects of artificial nighttime light on insect populations. We must carry out a more thorough and in-depth investigation in order to comprehend the complex dynamics at work. This larger investigation should cover not only the declining numbers of insects but also the wider effects of their mortality on the While India does not have specific legislation targeting light pollution, the existing environmental laws provide a framework for addressing the issue. Strengthening the enforcement of these laws and raising public awareness about the ecological impacts of artificial lighting can help mitigate the problem and protect insect biodiversity [17]. Ecosystem and local plants. Knowing how ALAN affects insect mortality is a crucial component of our study. Insects are vital to the health of ecosystems because they are involved in pollination, nutrient cycling, and food chain dynamics. Because of this, the effects of their demise on nutrient distribution, plant-pollinator interactions, and the overall ecological balance must be carefully evaluated and cannot be negatively impacted by this straightforward observational research [18]. According to our research, light pollution (ALAN) is causing insect populations to fall, which may have a negative impact on the ecosystem. This indicates that light pollution is a significant ecological danger that is only starting to emerge. This problem presents more general questions regarding the sustainability and stability of our ecosystems than only the short-term impacts of light pollution on insects. Therefore, considering the growing urbanisation and rising usage of artificial light at night, this research is both urgently needed and highly relevant [19]. The growing concern about increased urban lighting and its detrimental effects on insect populations underscores the

urgent need for comprehensive environmental management. Light pollution disrupts insect behavior, reproduction, and survival, contributing to biodiversity loss and ecological imbalance. While international laws, such as the Convention on Biological Diversity (CBD), and various national regulations, including India's Environment (Protection) Act, 1986, and Wildlife Protection Act, 1972, provide frameworks for addressing these issues, their enforcement remains inconsistent [20].

Strengthening legal frameworks and promoting sustainable urban lighting practices are crucial steps to mitigate light pollution. This involves implementing stricter regulations, enhancing public awareness, and integrating light pollution considerations into urban planning and environmental policies. Future research should focus on developing innovative lighting technologies and strategies that minimize ecological impacts. By prioritizing these measures, we can protect insect populations and ensure a balanced and healthy ecosystem [21].

#### DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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