

## Investigation on the attraction of insects to artificial light during nighttime in four distinct agriculture habitats of Deccan plateau in India

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### Abstract

In this study, we aimed to collect the different species of insects in different habitats like maize field, paddy field, chilly field and onion field. Aim is to note down all the species of insects that are collected for the broader exploration of the phenomenon of the phototaxis. The fluorescent lights were operated during night time at night 7:00PM to 4:00AM to collect insects attracted to the light, this is repeated frequently for about four months and collected the several times. Number of insects with different orders of 461 Hemiptera, 706 Coleoptera, 277 Lepidoptera, 481 Orthoptera, 179 Dictyoptera, 5 Hymenoptera, 378 Odonata, and 402 Diptera including 40 different species were recorded. *Asiopus minimus*, *Pachnaeus litus*, *Scopula benitaria*, *Acyphas chionotis*, *Trilophidia annulata*, *Blatella germanica*, *Conocephalus maculatus*, *Agriacris magnifica*, *Gryllus lineaticeps* were nine common species found in all the four habitats. The study observed that the highest insect species (21 species) found in Paddy field followed by Maize and Chilly fields (19 species) and the least species were found in Onion field (16 species). *Helochares negatus* species recorded both in day and night.

**Keywords:** Koppal district, insects, light attracting, nocturnal, hemiptera, coleopteran, habitat

### Introduction

In the realm of the natural world, one of the most interesting and confusing phenomena is the mesmerizing attraction of insects to artificial light sources. The sight of moths, beetles, and other nocturnal creatures circling around streetlights, porch lamps, or even a simple campfire has captivated curiosity for generations. This behaviour, known as phototaxis, is a fascinating yet complex level of insect biology that raises questions about navigation, survival, and the complicated interplay between these tiny creatures and the modern human environment.

The reasons behind this captivating behaviour are miscellaneous. First and foremost is the role of light in navigation. Many insects use natural light sources like the moon and stars for navigation. Artificial lights can confuse them, causing them to circle the light source. Artificial light can disrupt the natural orientation of nocturnal insects, causing them to become disoriented and circle the light source in confusion. Grunsven *et al.*, (2014) [3].

Light can attract insects that are predators or prey. Predatory insects may be drawn to areas with other insects circling lights, while those that feed on nectar might be attracted to artificial lights near flowers. Moreover, light can be misleading in terms of temperature. Insects are ectothermic creatures, meaning their body temperature is regulated by external environmental factors. They are often drawn to light sources because they emit heat, and insects may perceive this warmth as a potential heat source or a way to regulate their body temperature. Wakefield *et al.*, (2016) [8]. Insects like moths are known to use moonlight for mate, location, and artificial lights can mimic the brightness of the moon, confusing them into thinking they have found a potential mate. This misguided attraction can disrupt their natural mating behaviour. Fabian *et al.*, (2023) [2].

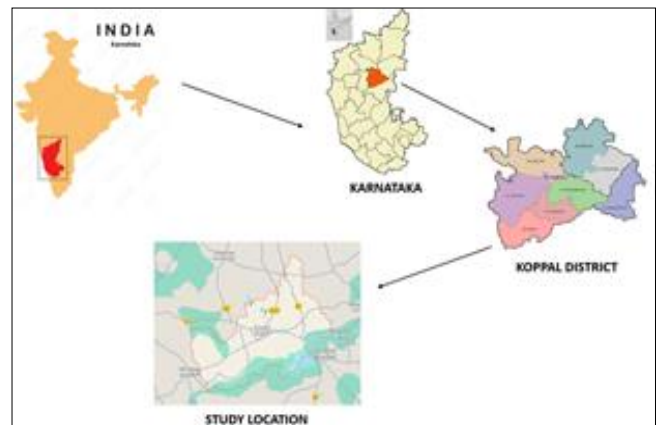
Beyond these factors, artificial lights can randomly create hotspots for insect activity, which can have ecological

effect. Predatory insects may be drawn to areas where other insects are circling lights leading to altered predator-prey dynamics. This attraction to light can sometimes have negative consequences for both insects and humans, as it can lead to increased insect presence in certain areas and interfere with their natural behaviour.

In this study, we aimed to collect the different species of insects in different habitats like maize field, paddy field, chilly field and onion field. Aim is to note down all the species of insects that are collected for the broader exploration of the phenomenon of the phototaxis. The study will be helpful for the future studies which will be conducted in the area and also to study the behavior of the nocturnal insects in different habitats.

### Study area

The study was conducted at following four different habitats of Koppal district (Table -1) (Fig. -1) for four months from June 2023 to September 2023.



**Fig 1:** Map of the study area

**Table 1:** Sites chosen for the study

Sl. No.	Site Name	Latitude and Longitude		Habitat
01.	Koppal city out skirts	Latitude: 15.308148°N	Longitude:76.14687°E	Maize field
02.	Ojanhalli, Koppal District	Latitude: 15.3507171° N	Longitude:76.1554221°E	Paddy field
03.	Ojanhalli, Koppal District	Latitude: 15.380453° N	Longitude:76.146803°E	Chilly field
04.	Ojanhalli, Koppal District	Latitude: 15.379193° N	Longitude:76.147012°E	Onion field

Four different habitats (Figure-2) were selected to investigate how insect attracts to artificial light differs in a different agriculture settings. By choosing four different locations within Koppal taluk, the study accounted for

variations in soil types, vegetation, and microclimates that may influence insect behavior. The samples were collected during the night between (7 PM-4AM) fortnightly for four months Kurmi *et al.*, (2019) [4].



**Fig 2:** Map showing four different locations of the study area

The light sources were installed at each study site using fluroscent bulbs (Table-2) to attract a wide range of insect species due to their known attractiveness. The light sources were mounted on poles approximately 1.5 meters above the ground level, (Schauff, 2001) [1]. The lights were strategically placed within the selected different study sites. The lights were operated during night time hours when insects are most active. The lights were turned on at night

7:00PM and turned off at morning 4:00AM to collect insects attracted to the light, this is repeated frequently for about four months and collected the several number of insects species that are attracting to the light source at four different habitats.

Insect collection, preservation and identification were done with standard procedures.

**Table 2:** Product information of the bulb used in the study

Lamp	Abbreviation	Luminance (lm)	Wattage (W)	CCT	Model_name	Manufacturer
Incandescent bulb	LED	1260lm	20	6500k	Lumistar LED bulb	Made in India

**Results**

The present study was carried out to study the diversity of insects which are attracting towards artificial light at night of four different habitats i.e. maize, paddy, chilly and onion agricultural fields (Fig-2). Study conducted over a span of four months and have revealed an interesting perspective on nocturnal Insects populations in diverse agricultural settings. Different insect species were found in four different

habitats. During the period of study a total of 2889 insects were collected (Table-3). The distribution of number of individuals of these insects belonging to different orders are as follows: 461 Hemiptera, 706 Coleoptera, 277 Lepidoptera, 481 Orthoptera, 179 Dictyoptera, 5 Hymenoptera, 378 Odonata, and 402 Diptera including 40 different species (Figure-4).

**Table 3:** List of the light attracting insects (No of individuals) collected during the study period

Sl no.	Name of the species.	Jun15	Jun30	Jul 15	Jul 30	Aug15	Aug30	Sep15	Sep30	Total
01.	<i>Calliphara excellens</i>	0	4	1	3	1	0	6	5	20
02.	<i>Anomala pallida</i>	6	10	13	17	12	20	27	30	135
03.	<i>Cretonotos gangis</i>	17	14	07	10	15	11	05	19	98
04.	<i>Acheta domesticus</i>	23	29	21	18	07	30	16	34	178
05.	<i>Legnotus fumigatus</i>	28	39	33	46	38	45	57	69	355
06.	<i>Eupompha schwarzi</i>	0	0	1	0	0	0	2	1	04
07.	<i>Amantis reticulata</i>	4	6	2	5	1	0	6	5	29
08.	<i>Nezara viridula</i>	4	9	3	7	5	2	8	7	45
09.	<i>Amata huebneri</i>	2	1	4	1	0	0	1	1	10
10.	<i>Parotis marginata</i>	6	8	12	7	18	9	14	13	87
11.	<i>Megachile lanata</i>	0	1	0	0	2	0	1	1	05
12.	<i>Blatta orientalis</i>	3	6	4	7	2	5	1	8	36
13.	<i>Sameodes cancellais</i>	5	7	3	6	8	2	3	1	35
14.	<i>Neostylopyga rhombifolia</i>	1	0	0	0	2	0	1	2	06
15.	<i>Celosterna scabrator</i>	12	17	14	11	13	9	16	09	101
16.	<i>Asiopus minimus</i>	16	07	19	11	07	17	10	09	96
17.	<i>Chlaenius orbicollis</i>	05	03	09	02	06	05	08	12	50
18.	<i>Tenebroides mauritanicus</i>	00	04	09	05	03	10	02	07	40
19.	<i>Tetraglenes hirticornis</i>	01	05	04	01	02	07	00	03	23
20.	<i>Ponometia erastrioides</i>	00	00	01	00	01	00	02	07	11
21.	<i>Oedemera marmorata</i>	00	04	07	02	05	03	01	06	28
22.	<i>Pachnaeus litus</i>	00	02	00	03	01	01	04	03	14
23.	<i>Scopula benitaria</i>	03	00	02	01	04	00	06	09	25
24.	<i>Pantala flavescens</i>	00	00	00	18	19	29	45	59	170
25.	<i>Coccinella transversalis</i>	00	00	12	07	09	14	06	19	67
26.	<i>Cletus trigonus</i>	00	01	06	03	00	01	04	08	23
27.	<i>Heterorrhina elegans</i>	00	01	00	02	01	03	02	04	13
28.	<i>Micraspis discolor</i>	00	01	00	04	03	05	09	10	32
29.	<i>Agriocnemis femina</i>	11	18	23	21	17	21	43	54	208
30.	<i>Limnogonus recens</i>	00	01	04	02	05	02	01	03	18
31.	<i>Acyphas chionotis</i>	00	01	04	02	01	00	01	02	11
32.	<i>Eristalis arbustorum</i>	00	02	04	09	14	17	21	16	83
33.	<i>Trilophidia annulata</i>	01	05	02	04	09	10	16	29	76
34.	<i>Blattella germanica</i>	10	17	14	12	19	09	11	16	108
35.	<i>Conocephalus maculatus</i>	03	01	04	07	02	00	07	15	39
36.	<i>Agriacris magnifica</i>	00	03	02	01	04	03	07	13	33
37.	<i>Gryllus lineaticeps</i>	10	16	13	26	22	19	28	21	155
38.	<i>Otiorynchus sulcatus</i>	01	00	06	00	03	00	07	13	30
39.	<i>Minettia longipennis</i>	16	21	28	29	37	61	54	73	319
40.	<i>Helochaeres negatus</i>	06	09	12	17	00	04	08	17	73
Total		194	273	303	327	318	374	467	633	2889

## Discussion

The present investigations carried out for the first time on insects attracting towards artificial light at night for the period of four months (from June 2023 to September 2023) at four different habitats of Koppal district. The study revealed that a total of 2,889 number of insects individuals were collected (Table -3). The highest number of insects were recorded in paddy field of 21 species (1257 individuals) belonging to 16 families, followed by the maize field of 19 species (1001 individuals) belonging to 14 families, similarly chilly field of 19 species (430 individuals) belonging to 9 families, and the least in the onion field 16 species (201 individuals) belonging to 6 families (Table-4 and Fig -3).

Among these orders, Coleoptera was the most abundant with 24% (706 individuals) showing its dominance within the habitats, Hymenoptera exhibited the lowest abundant with 0% (5 individuals) making the least prevalent order. Lepidoptera comprised of 10% (227 individuals), Dictyoptera accounted 6% (179 individuals), followed by Diptera with 14% (402 individuals), and Odonata 13% (378 individuals) (Figure-4). These variations in insect orders in

agricultural habitats occur due to habitat preferences, competitive interactions, human activities and differences in life cycle and reproduction. Some orders thrive in specific habitats because of resource compatibility. Norela *et al.*, (2013) observations revealed that Coleoptera followed by Orthoptera, Lepidoptera, Hemiptera and Hemiptera were the dominating species observed in the agricultural habitats. Similarly, Sharma *et al.*, (2010), Meeran *et al.*, (2021) conducted a survey spanning from December 2019 to February 2020. Their findings revealed a total of 587 insects, encompassing 26 species and 9 orders.

Insects are more abundant in paddy fields (Fig- 5) due to a combination of factors that create a favourable environment for them such as, water availability. The lower humidity and moisture levels in onion fields, compared to paddy fields, also make them unfavorable for insect populations and fewer food resources available in onion field, contributing to the reduced insect abundance. These combined conditions create an environment less favorable for many insect species in onion fields. The presence and abundance of insect species can be affected by factors such as climate, vegetation, and their interactions (Wolda, 1978) <sup>[10]</sup>.

The study has documented several types of species in four different habitats. During June month of collection 477 insects were collected followed by July month 628 individuals, August month 691 individuals and during September month of 1093 insects were collected (Fig-6). The fluctuation in insect collection, with the highest numbers in September and the lowest in the June, can be attributed to various factors such as food availability temperature, humidity, and environmental conditions collectively contribute to the seasonal variation in insect numbers (Wolda, 1988) [11]. *Legnotus fumigatus* was found high in number during august and September month in maize field. *Scopula benitaria* moths were found least in number. *Minettia longipennis* flies was found abundantly in the paddy field, simultaneously *Cretonotos gangis* and *Parotis marginata* were high where as, *Megachile lanata* species was attracted fewer in chilly and onion fields (Fig-5).

In tropical regions, various climate conditions can impact the seasonal patterns of insects (Wolda and Fisk, 1981) [9]. The transition from dry to rainy season is a crucial factor in many areas (Wolda, 1988) [11]. Insect diversity is influenced by factors such as temperature, relative humidity, wind speed, and their abundance is dependent on seasonal duration, rainfall, surrounding vegetation, and agricultural methods (Pimentel and Wheeler, 1973). According to Vijayababu *et al.*,(2016), climate change is expected to bring about significant changes in the agricultural ecosystem, resulting in shifts in insect population levels.

During the study period *Asiopus minimus*, *Pachnaeus litus*, *Scopula benitaria*, *Acyphas chionotis*, *Trilophidia annulata*, *Blatella germanica*, *Conocephalus maculatus*, *Agriacris magnifica*, *Gryllus lineaticeps* were nine common species found in all the four habitats (Fig- 7). The study observed that the highest insect species (21 species) found in Paddy field followed by Maize and Chilly fields (19 species) and the least species were found in Onion field (16 species) (Fig-8).

The study has recorded most of the diurnal insects attracted to the light at night (Table-5). The attraction of diurnal insects to light at night is often a result of their navigation mechanisms becoming disrupted by artificial light sources. Diurnal insects which are active during the day, use various natural cues for orientation and navigation. These cues can include the position of the sun, the polarization of daylight, and landmarks on the landscape. When artificial lights are introduced at night, they can interfere with these natural cues. The strong and consistent light sources can confuse diurnal insects, causing them to become disoriented leading them to circle the light source.

The results of the study provide crucial insights on the abundance of different nocturnal insect species attracted to artificial light in various agricultural fields of Koppal district, these findings raise questions about the potential impact of light on insect behavior and its ecological consequences. Owens and Lewis (2018) [5] worked on the impact of artificial light on nocturnal insects and reveals that artificial light significantly impacts nocturnal insects. These impacts range from attraction to light sources, effects on the behavior and ecology, and possible ecological impacts. Nocturnal insects are drawn to artificial light, often cause problems such as increased mortality rates due to disorientation and collisions. The disruption of their behavior, including mating and foraging, can lead to

population declines and changes in species composition. (Desouhant *et al.*, 2019) [1] Artificial light at night (ALAN) affects the synthesis of melatonin, an important hormone that regulates circadian rhythms in insects. In many species melatonin is generally produced at night and suppressed during day. However, the pattern of melatonin synthesis may be more complex due to differences in daily peak values and concentrations in different species. Disruption of melatonin synthesis by ALAN may have important effects on circadian regulation and all physiological processes in these insects. The ecological implications of this light attraction are significant, affecting insect populations and their interaction with the environment. *Helochares negatus* species recorded both in day and night.



Fig 3: Photographs showing the collections of light attracting insects of four different habitats

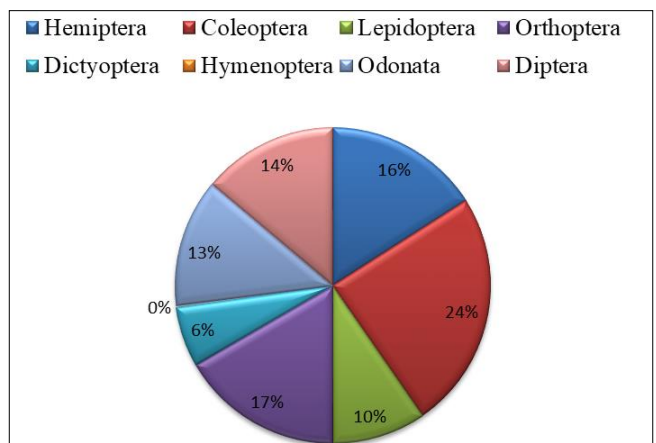


Fig 4: Percentage of distribution of insects across different orders

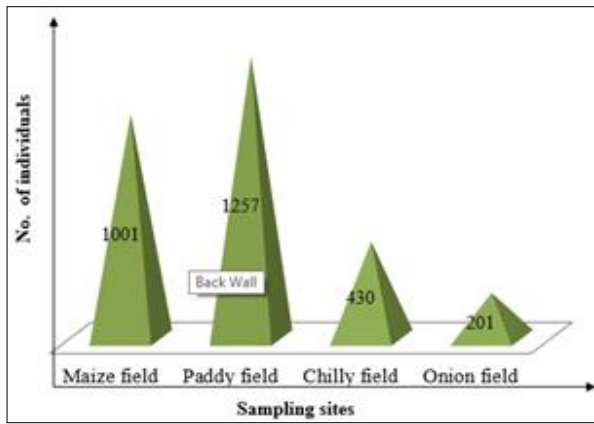


Fig 5: Total collection of insects (Number of individuals) in four different habitats

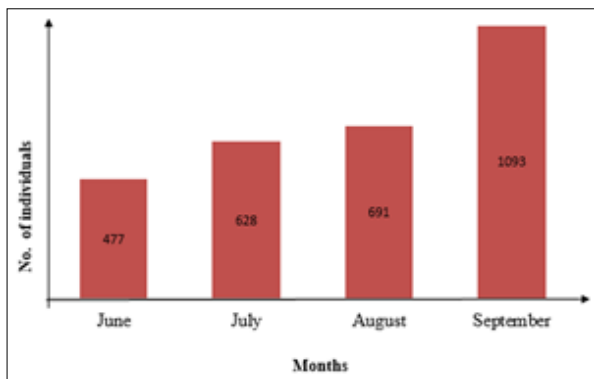


Fig 6: Total number of Insects individuals collected during study period

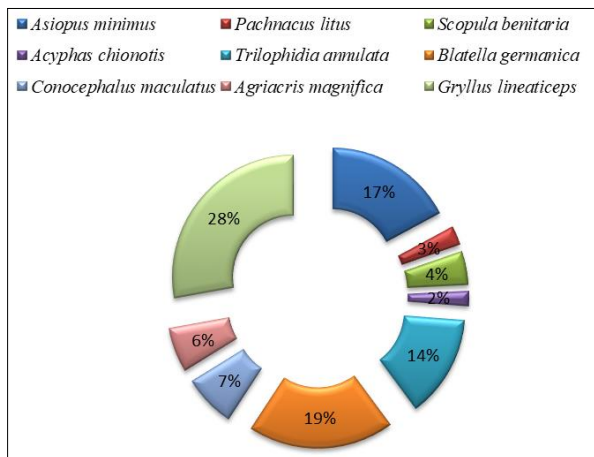


Fig 7: Percentage of common Insects species observed in all four habitats

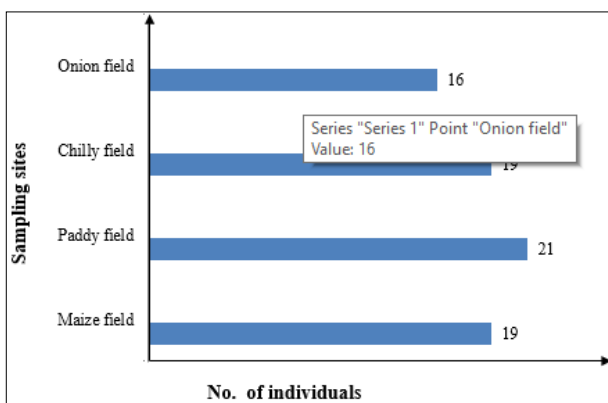


Fig 8: Total number of insect species observed in different habitats

Table 4: Insects observed in different habitats during the study period

Sl.No.	Name of the species	Maize field	Paddy field	Chilly field	Onion field
01.	<i>Calliphara excellens</i>	-	-	+	-
02.	<i>Anomala pallida</i>	+	-	-	-
03.	<i>Cretonotos gangis</i>	-	-	+	-
04.	<i>Acheta domesticus</i>	+	-	-	-
05.	<i>Legnotus fumigatus</i>	+	-	-	-
06.	<i>Eupompha schwarzi</i>	-	-	+	-
07.	<i>Amantis reticulata</i>	-	-	+	-
08.	<i>Nezara viridula</i>	-	-	+	-
09.	<i>Amata huebneri</i>	-	-	-	+
10.	<i>Parotis marginata</i>	+	-	-	+
11.	<i>Megachile lanata</i>	-	-	+	+
12.	<i>Blatta orientalis</i>	+	-	-	+
13.	<i>Sameodes cancellais</i>	+	-	-	+
14.	<i>Neostylopyga rhombifolia</i>	-	-	+	+
15.	<i>Celosterna scabrator</i>	+	+	+	-
16.	<i>Asiopus minimus</i>	+	+	+	+
17.	<i>Chlaenius orbicollis</i>	+	-	+	-
18.	<i>Tenebroides mauritanicus</i>	+	-	-	-
19.	<i>Tetraglenes hirticornis</i>	-	-	+	-
20.	<i>Ponomelia erastrioides</i>	-	-	-	+
21.	<i>Oedemera marmorata</i>	+	-	-	-
22.	<i>Pachnaeus litus</i>	+	+	+	+
23.	<i>Scopula benitaria</i>	+	+	+	+
24.	<i>Pantala flavescens</i>	-	+	-	-
25.	<i>Coccinella transversalis</i>	-	+	-	-
26.	<i>Cletus trigonus</i>	-	+	-	-
27.	<i>Heterorrhina elegans</i>	-	+	-	-
28.	<i>Micraspis discolor</i>	-	+	-	-
29.	<i>Agriocnemis femina</i>	-	+	-	-
30.	<i>Limnogonus recens</i>	-	+	-	-
31.	<i>Acyphas chionotis</i>	+	+	+	+
32.	<i>Eristalis arbustorum</i>	-	+	-	-
33.	<i>Trilophidia annulata</i>	+	+	+	+
34.	<i>Blattella germanica</i>	+	+	+	+
35.	<i>Conocephalus maculatus</i>	+	+	+	+
36.	<i>Agriacris magnifica</i>	+	+	+	+
37.	<i>Gryllus lineaticeps</i>	+	+	+	+
38.	<i>Otiorynchus sulcatus</i>	-	+	-	-
39.	<i>Minettia longipennis</i>	-	+	-	-
40.	<i>Helochares negatus</i>	-	+	-	-
Total		19	21	19	16

Table 5: List of insect species activity patterns attracted to artificial light at night

Sl no.	Name of the species.	Diurnal	Nocturnal	Remarks
01.	<i>Calliphara excellens</i>	+	-	-
02.	<i>Anomala pallida</i>	+	-	-
03.	<i>Cretonotos gangis</i>	+	-	-
04.	<i>Acheta domesticus</i>	+	-	-
05.	<i>Legnotus fumigatus</i>	-	+	-
06.	<i>Eupompha schwarzi</i>	+	-	-
07.	<i>Amantis reticulata</i>	+	-	-
08.	<i>Nezara viridula</i>	+	-	-
09.	<i>Amata huebneri</i>	+	-	-
10.	<i>Parotis marginata</i>	+	-	-
11.	<i>Megachile lanata</i>	+	-	-
12.	<i>Blatta orientalis</i>	-	+	-
13.	<i>Sameodes cancellais</i>	+	-	-
14.	<i>Neostylopyga rhombifolia</i>	+	-	-
15.	<i>Celosterna scabrator</i>	+	-	-
16.	<i>Asiopus minimus</i>	+	-	-
17.	<i>Chlaenius orbicollis</i>	+	-	-
18.	<i>Tenebroides mauritanicus</i>	+	-	-

19.	<i>Tetraglenes hirticornis</i>	+	-	-
20.	<i>Ponometia erastrioides</i>	-	+	-
21.	<i>Oedemera marmorata</i>	+	-	-
22.	<i>Pachnaeus litus</i>	+	-	-
23.	<i>Scopula benitaria</i>	+	-	-
24.	<i>Pantala flavescens</i>	+	-	-
25.	<i>Coccinella transversalis</i>	+	-	-
26.	<i>Cletus trigonus</i>	+	-	-
27.	<i>Heterorrhina elegans</i>	+	-	-
28.	<i>Micraspis discolor</i>	+	-	-
29.	<i>Agriocnemis femina</i>	+	-	-
30.	<i>Limnogonus recens</i>	+	-	-
31.	<i>Acyphas chionotis</i>	+	-	-
32.	<i>Eristalis arbustorum</i>	+	-	-
33.	<i>Trilophidia annulata</i>	+	-	-
34.	<i>Blattella germanica</i>	-	+	-
35.	<i>Conocephalus maculatus</i>	+	-	-
36.	<i>Agriacris magnifica</i>	+	-	-
37.	<i>Gryllus lineaticeps</i>	-	+	-
38.	<i>Otiorynchus sulcatus</i>	-	+	-
39.	<i>Minettia longipennis</i>	+	-	-
40.	<i>Helochares negatus</i>	+	+	Both
	Total	33	07	01

### Conclusion

In conclusion, widespread of nocturnal artificial lights specially in urban areas, disrupts the habitats of nocturnal species. This circumstance can lead to disorientation among insects and cause various complications, including behavioral changes such as mating and foraging and increased mortality rates. These effects can potentially result in population declines and shifts in species composition. Present study recorded 40 different insect species. This study provides insight into the relationship between lighting and nocturnal insects in agricultural environments. Understanding these changes is important for sustainable crop management, biodiversity conservation and public health. It is important to consider the impact of artificial light on nocturnal ecosystems and develop strategies to mitigate any adverse effects. Further research in this area may help us better understand the behavior of these insects and improve knowledge of conservation and pest management in changing world.

### Recommendations

- Encourage the use of energy-efficient and insect-friendly lighting solutions.
- Raise awareness among farmers and the public about the potential ecological consequences of artificial light attraction for insects.
- Explore the development of mitigation measures to minimize the negative effects of artificial light on insects.

### Conflict of Interest

The authors declare that they have no conflict of interest.  
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