International Journal of Zoology Studies
ISSN: 2455-7269
Impact Factor: RJIF 5.14
www.zoologyjournals.com
Volume 3; Issue 3; May 2018; Page No. 38-41

A study on the sensitivity of insects to different colours of light

Chitra
Postgraduate and Research, Department of Zoology, CMS College, Kottayam, Kerala, India

Abstract
The study was conducted to assess the influence of different lights in insect attraction. The experiments were carried out from April to July 2014, at night from 7 p.m. to 8 p.m. Insect light traps with Incandescent bulb, Compact fluorescent lamp, green, blue and red light bulbs of 25 watts were used for attracting the insects. From the same location four monthly sampling was carried out for each set of experiments. Seventy five species of insects belonging to nine orders (Neuroptera, Hemiptera, Diptera, Lepidoptera, Ephimeroptera, Coleoptera, Hymenoptera, Isoptera and Orthoptera) were identified and their variations were recorded. The results indicate that the light emitted by Incandescent bulb is more effective in insect attraction but the species richness was found more in blue light.

Keywords: light attracted insects, different colours of light, nocturnal insects, light trap

1. Introduction
Humans have been searching for ways to illuminate the night for millennia. Until the invention of electric lights, the affect of the light on the ecosystem was fairly small. However, in the present day, artificial light has completely altered the nighttime environment throughout much of the world and to some extent leading to ecological light pollution. Ecological light pollution has a major effect on the behavior and population of many organisms. Overall, these effects come from changes in orientation and the attraction or repulsion from the artificial light. This can affect reproduction, communication, foraging, and migration (Longcore &Rich 2004) [1].

It is well known that a wide variety of insects are affected by artificial light. One of the most known affects is the flight-to-light response. Artificial lights attract moths, flies, mayflies, beetles, and all sorts of other insects. Night flying insects evolved to navigate by the light of the moon. Artificial lights interfere with an insect's ability to detect the moonlight. They appear brighter, and radiate their light in multiple directions. Once an insect flies close enough to a light bulb, it attempts to navigate by way of the artificial light, rather than the moon. Since the light bulb radiates light on all sides, the insect simply cannot keep the light source at a constant angle, as it does with the moon. It attempts to navigate a straight path, but ends up caught in an endless spiral dance around the bulb.

Like all animals, insect's sensitivity to light varies by wavelength. Their range of vision goes from less than 340nm to more than 700nm (Langer *et al*. 1978) [2]. The maximum responses is reported to been obtained within the green band around 520nm. The responses dropped sharply toward the red band and less sharply toward the violet (Weiss 1994) [3].

Light and colour play an important part in the reactions of insects. The reaction to light is called phototropism. Insects have different types of photoreceptors, which permit various insects to perceive the form of objects, patterns, movements, distance certain colours, light intensity, the polarization plane of light, light versus darkness, and the length of the photoperiod. In insects, these receptors take the form of dermal light response, compound eyes, stemmata (lateral ocelli), and dorsal ocelli. These receptors perceive light by means of pigment that absorbs light of a particular wavelength, and thus stimulates associated neurons.

The insect eye is well adapted to perceive movement, but a complex form perception is also possible. The eye is not equally sensitive to all wavelengths, and further, its sensitivity varies under different conditions. There are seven colors in the light spectrum: red, orange, yellow, green, blue, indigo and violet also known as visible lights. Each colour lights have different wavelength and frequency. Red has the longest wavelength and lowest frequency and violet has the shortest wavelength and highest frequency. The wavelengths of visible lights range from 400-700 nm (White, 1980; Ditchbum, 2001) [4]. The colour vision has been shown behaviorally to occur in a number of species belonging to the orders- hymenoptera, diptera, coleoptera, lepidoptera, neuroptera, heteroptera, homoptera and orthoptera. The ability to discriminate between lights of different wavelengths depends on the possession of photo pigments with maximum sensitivity to light of different wavelengths (Hienton, 1974) [5]. Insects may respond to light and other stimuli directionally or in a qualitative, but undirected, manner. Hence the present work was undertaken to find the influence of different lights in insect attraction.

2. Materials and Methods
In this study, the Insects were collected from a courtyard of Murani locality in Mallappally municipality of Pathanamthitta district in Kerala, India. The area in and around the courtyard had good amount of vegetation. The study was carried out from April 2014 to July 2014, at night from 7 p.m. to 8 p.m. the insects were collected with help of light trap using 25 watt bulbs of different colours. In this study, light was suspended

about 2.5m in height above the ground level in front of a white sheet, giving flying insects a surface on which they can land. The ground perpendicular to the bulb was covered with rectangular plastic basins, with water in them so that the insects which try to rest on the ground can also be collected. The big insects from the area were collected using insect net and forceps (from the white sheet). Insect light trap with incandescent bulb, compact fluorescent lamps (CFL), red, green and blue were used for attracting the insects. These setups with different colour lights were placed a distance from one another. From the same area four monthly samplings were carried out for each set of experiments. The insects collected in each sampling were sorted out order wise and the numbers were recorded. The large hard bodied insects were dried and pinned in insect boxes, while Small ones were preserved in 70% alcohol and were brought to the laboratory for identification. Species richness index was calculated using the formula: number of species/√number of insects (Menhinick, 1964) [6].

3. Result and Discussion

A bulk of literature is available pertaining to the influence of light on locomotion (Fraenkel and Gunn, 1961) [7]. The phototactic reaction of insects can be modified or reversed by several factors such as temperature, moisture, food, and age. Adults of *Syrpid* (Eristalis) are attracted to light at temperature between 10 and 30 C but move away from it at high temperatures (Dolley and white, 1951) [8]. The insects are attracted more too ultraviolet light than to other form of light. Some insects can detect and respond to polarized light. Wavelength discrimination in insects follows trichromatic theory of colour vision. The trichromatic receptor system is well developed in the honeybee with independent maximum sensitivity for each receptor, without purkinje shift. Insect can see in a range of 300-650nm but mostly prefer 300-420nm, which include UV light.

Light trap has been successfully used by various workers for sampling insects. It is useful tool particularly to collect moths and beetles in addition to several other nocturnal insects. In the present study, the collection of insects with the help of different lights showed that some insect's orders are not attracted to certain colours of light.

The data of insect collected with the help of different lights during April to July 2014 are presented in table No. - 2 to 8 and figure- 1 to 4.

A total of 3456 insects (75 species) belonging to 9 orders were collected during the experimental period. The ordinary light produced by incandescent bulb attracted the maximum number of species (41) and the maximum number of insects (1749). Numerically ordinary light attracted 50.60% where as the CFL light 34.02%, red light 5.20%, green light 3.38% and blue light 6.77% insects. Insect attraction with the species richness index from 0.98 to 1.503 was recorded (table 7). In the present study the maximum number of insects 1143 was obtained in the month of April 2014 and the minimum 618 in the month of July 2014 (table 8).

CFL and incandescent bulb light attracted species belonging to all the nine orders but the insects belonging to order orthoptera and isoptera in red light, neuroptera in blue light, lepidoptera and ephimeroptera in green light were not attracted.

Table 1: List of plants recorded from the area

1) *Cocos nucifera*	**15) *Macaranga spp.***
2) *Hevea brasiliensis*	16) *Swietenia macrophylla*
3) *Tectona grandis*	17) *Artocarpus altilis*
4) *Musa acuminate*	18) *Artocarpus hirsutus*
5) *Jasminum spp.*	19)*Caryota spp.*
6) *Mangifera indica*	20) *Nicotiana tabacum*
7) *Hibiscus rosa-sinensis*	21) *Amorphophallus paeoniifolius*
8) *Psidium guajava*	22) *Vigna unguiculata*
9) *Artocarpus heterophyllus*	23) *Coccinia grandis*
10) *Coffea Arabica*	24) *Epipremnum aureum*
11) *Carica papaya*	25) *Ocimum tenuiflorum*
12) *Garcinia gummi-gutta*	26) *Tagetes spp.*
13) *Colocasia esculenta*	
14) *Amaranthus dubius*	

Table 2: Number of Insects attracted towards Incandescent bulb light

Order	**Month**				**Number of species**	**Total**
	April	**May**	**June**	**July**		
Neuroptera	36	24	21	15	1	96
Hemiptera	39	24	30	27	2	120
Diptera	75	60	105	66	1	306
Lepidoptera	120	99	75	60	2	354
Ephimeroptera	24	27	30	21	4	102
Coleoptera	117	99	105	90	16	411
Hymenoptera	39	48	60	66	9	213
Isoptera	33	27	30	24	4	114
Orthoptera	15	9	6	3	2	33
Total	498	417	462	372	41	1749

Table 3: Number of Insects attracted towards Compact Fluorescent lamp (CFL)

Order	Month				Number of species	Total
	April	May	June	July		
Neuroptera	12	9	3	3	2	27
Hemiptera	42	30	27	24	2	123
Diptera	30	27	24	21	2	102
Lepidoptera	84	30	15	12	7	141
Ephimeroptera	24	15	9	6	1	54
Coleoptera	159	129	9	12	14	309
Hymenoptera	87	45	24	18	5	174
Isoptera	54	57	54	48	2	213
Orthoptera	15	9	6	3	4	33
Total	507	351	171	147	39	1176

Table 4: Number of Insects attracted towards Green light (Insects belonging to order Lepidoptera and ephimeroptera were not attracted)

Order	Month				Number of species	Total
	April	May	June	July		
Neuroptera	6		3		1	9
Hemiptera	3	6	12	6	2	27
Diptera	3		3		2	6
Lepidoptera						
Ephimeroptera						
Coleoptera	6	6		3	2	15
Hymenoptera	15	6		3	4	24
Isoptera	9	12		3	2	24
Orthoptera		3	3	6	1	12
Total	42	33	21	21	14	117

Table 5: Number of Insects attracted towards Red light (Insects belonging to the order Isoptera and Orthoptera were not attracted)

Order	Month				Number of species	Total
	April	May	June	July		
Neuroptera	24	12	15	9	2	60
Hemiptera		24	9	3	1	36
Diptera	3	12	6	3	2	24
Lepidoptera		6			2	6
Ephimeroptera	6	3			1	9
Coleoptera	12	15		6	9	33
Hymenoptera		3	6	3	2	12
Isoptera						
Orthoptera						
Total	45	75	36	24	19	180

Table 6: Number of Insects attracted towards blue light (Insects belonging to the order Neuroptera were not attracted)

Order	Month				Number of species	Total
	April	May	June	July		
Neuroptera						
Hemiptera	3	6	6	3	1	18
Diptera	6	6	9	9	2	30
Lepidoptera	3	9	6	3	2	21
Ephimeroptera	3	3	3	3	3	12
Coleoptera	15	9	15	3	7	42
Hymenoptera	12	15	9	18	5	54
Isoptera	6	6	12	12	1	36
Orthoptera	3	9	6	3	2	21
Total	51	63	66	54	23	234

Table 7: Consolidate accounts of Insects recorded from different colours of light

Light used	Number of Orders	Number of Insects	Number of Species	Species Richness Index	Percentage (%)
Incandescent blub	9	1749	41	0.98	50.60
CFL	9	1176	39	1.13	34.02

Green	7	117	14	1.05	3.38
Red	7	180	19	1.41	5.20
Blue	8	234	23	1.50	6.77

Table 8: Consolidate accounts of Insects recorded during April-July 2014

Light used	Number of insects collected in different months				Total
	April	May	June	July	
Incandescent blub	498	417	462	372	1749
CFL	507	351	171	147	1176
Green	42	33	21	21	117
Red	45	75	36	24	180
Blue	51	63	66	54	234
Total	1143	939	756	618	3456

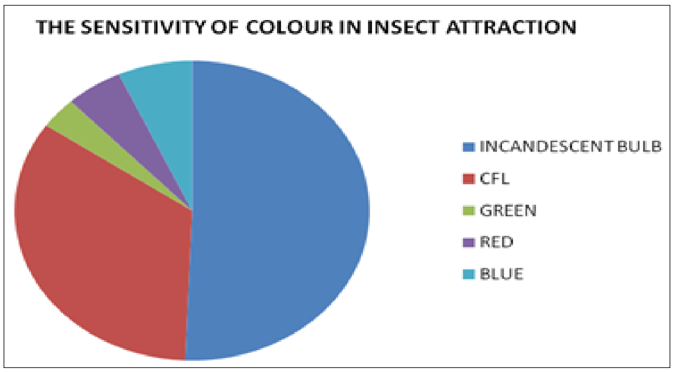

Fig 1: Graph showing the sensitivity of colour in Insect attraction

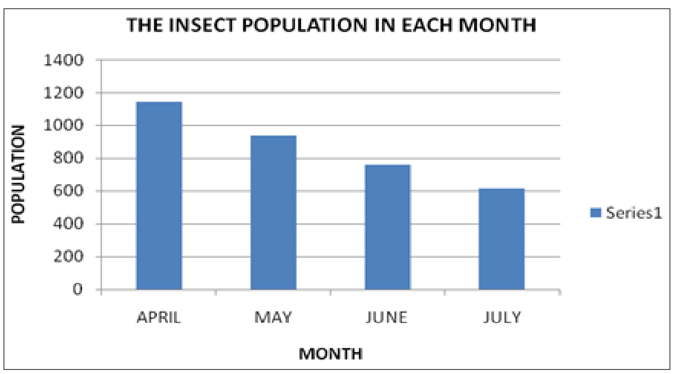

Fig 2: Graph showing the Insect populations in each month

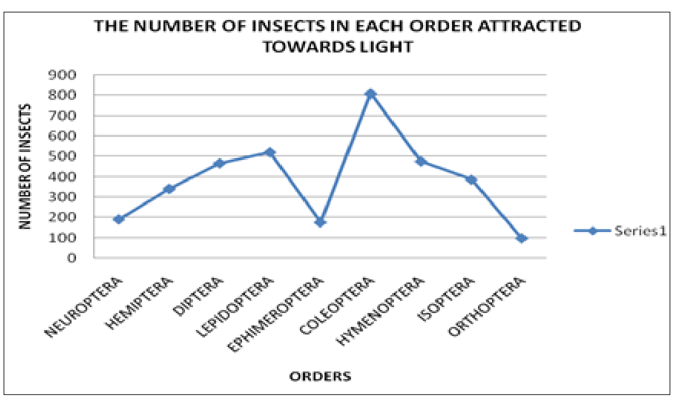

Fig 3: Graph showing the number of insects in each order attracted towards light

4. Conclusion

The sensitivity of the insect eye depends on the characteristics of the visual pigment, the nervous interconnections behind the eye and the extent to which the eye is adapted to the prevailing light condition (Chapman, 1978) [9].

The maximum number of insects collected was in the month of April (2014) and minimum in the month of July (2014). Such fluctuation in insect collection may be due to humidity, temperature and the vegetation. It has been observed that species of Ephimeropterans and Lepidopterans were not attracted by green lights, neuropterans by blue light and Isopterans and Orthopterans by red light.

The major objective of this study was to generate information in insect attraction to different colours of lights. The data indicates that the blue light has high species richness and the incandescent bulb light has the highest attractive power. The attraction of insects to different lights varies from insect to insect. The insect attraction to light is related with the temporary humidity and vegetation.

5. References

1. Longcore T, Rich C. Ecological light pollution. Frontiers in Ecology and the Environment. 2004; 2(4):191-198.
2. Langer H, Hamann B, Meinecke CC. Tetraehromatic visual system in the Moth Spodoptera exempta (Insecta: Noctnidae). Journal of Comparative Physiology. 1978; 129:235-239.
3. Weiss HB. Insect responses to colors. Journal of the New York Entomological society. 1944; 52:267-271.
4. White EG. Light-trapping frequency and data analysis-a reply. New Zealand Entomologist. 1989; 12(1):91-94.
5. Hienton TE. Summary of investigations of electric insect traps. Technical Bulletin No. 1498. Agricultural Research Service. United States agricultural department. Washington, DC. Issued, 1974.
6. Menhinick EF. A Comparison of Some Species-Individuals Diversity Indices Applied to Samples of Field Insects. Ecology. 1964; 45(4):859-861.
7. Stephens GC. The Orientation of Animals Kineses, taxes, and compass reactions. D. L. Gunn and G. F. Fraenkel. Dover, New York, 1961. x 376 pp. Illus. $2. Science. 1962; 136(3517):707-708.
8. Dolley WL, White JD. The Effect Of Illuminance On The Reversal Temperature In The Drone Fly, Eristalis Tenax. The Biological Bulletin. 1951; 100(2):84-89.
9. Chapman R, Simpson SJ, Douglas AE. The insects: Structure and function. Cambridge: Cambridge University Press, New York, 2013.