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Analysis of light patterns affecting the phototactic behavior of cockroaches

Sanjana Yadav and Newton Paul *

Department of Zoology, Isabella Thoburn College, Lucknow, India.

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Abstract

In general, phototactic movement allows organisms to maintain ideal advancement and physiological conditions. Not only can organisms respond to light's direction, but also to its intensity. Several defensive behaviours, especially those expressed by insects, are similarly considered as some instances of phototaxis. Photoreceptors are extremely specialized, light-sensitive cells containing photopigments that mediate phototactic responses. Cockroaches display negative phototaxis, indicating they are scared of light. Certain cockroach species undoubtedly prefer to reside in quiet, dimly lit environments, but some are similarly fond of light as humans are. At night, they'll assemble around windows or in front of TVs. Cockroaches usually escape from light because they are frightened of light.

Keywords: Phototaxis; Behaviour; Insect; Photoreceptors and cockroach

1. Introduction

A particular kind of locomotory movement that is referred to as phototaxis is the movement of a whole organism in a specific direction of or away from a light stimulus. Phototrophic organism's profit from this since it permits them to orient themselves optimally to receive light for photosynthesis. Cockroaches do not fear light, in contrast to what is widely believed.

While the majority of species do prefer the dark, others are attracted to light and can be seen gathering at night near windows or on TV screens. The vast majority of these nocturnal insect's scatter when confronted with light.

The wide range of photoreceptor complements amongst different species and tissues is responsible for the variation in phototactic responses. Tetrapyrrole compounds provide photosynthetic bacteria the capacity to orient themselves to most efficiently acquire the light that they convert into energy. Phytochromes are another type of protein pigment that is used by plants and other photosynthetic organisms to detect light, especially in the red and far-red regions of the visible spectrum. Retinal contains key carotenoid molecules involved in the vision of animals, including vertebrates, arthropods, and molluscs. Flavins, including riboflavin (vitamin B2), allow phototaxis in algae and plants.

Cockroaches have been known to exhibit phototactic behaviour, which is the movement of organisms in response to light. The study of this behaviour in cockroaches is important because it can help us understand how they respond to different environmental factors. One of the most important environmental factors that can influence phototactic behaviour in cockroaches is artificial lighting. In this paper, we investigate the effects of artificial lighting on phototactic behaviour in cockroaches, specifically their light-induced movement patterns. By conducting this study, we aim to gain a better understanding of how environmental factors influence the behaviour of cockroaches and how this information could be used in pest management strategies. This research will contribute to the development of more effective and sustainable methods for controlling cockroach populations.

* Corresponding author: Newton Paul

Cockroaches are generally negatively phototactic, meaning that they tend to move away from light [1]. Phototactic behaviour is a result of the sensitivity of the ocelli, which are specialized structures that detect light, in the nocturnal bees and cockroaches. However, these structures are poor at perceiving fast movements and lack UV-sensitive opsins [2]. Studies have shown that phototactic behaviour in insects is influenced by various factors such as temperature, humidity, light, rainfall, moonlight, and wind. For instance, insect phototactic rhythms are affected by rainfall, and moonlight can disrupt the nocturnal feeding activity of cockroaches [3]. The quality of shelter also plays a role in cockroach aggregation and movement patterns. Individual cockroaches tend to ignore poor quality shelters, leading to disordered movement patterns [4]. Cockroaches are known to be mechanical carriers of disease germs, which poses a risk to human health [5]. Previous research has conducted experiments on phototactic behaviour in cockroaches and observed negative phototaxis in response to light stimuli [6]. A study conducted on Turkestan cockroaches aimed to investigate the growth rate and thigmotactic behaviour under different conditions [7]. Understanding the factors that affect phototactic behaviour in cockroaches is important for controlling their movement patterns and developing effective pest management strategies.

The study on environmental factors influencing phototactic behaviour in cockroach's sheds light on the complex movement patterns of these insects. The negative phototactic behaviour of cockroaches is well-known, but this research highlights how individual cockroaches tend to ignore poor quality shelters, leading to disordered movement patterns. This study provides valuable insights into the factors that affect cockroach behaviour, which can be used to develop effective pest management strategies. The results suggest that lighting conditions play a significant role in cockroach movement, as they tend to avoid areas with bright light. Additionally, the presence of food and water sources can also affect their movement patterns. However, this study has some limitations, as the experiments were conducted in a laboratory setting and may not fully represent the natural environment. Future research can focus on investigating the effects of lighting and other environmental factors in natural settings. Overall, this study contributes to the ongoing advancement of knowledge in the field of pest management and lays the groundwork for developing more effective strategies to control cockroach populations.

2. Materials and methods

One rectangular cardboard box with a partition dividing it into two smaller compartments, live cockroaches, and a torch bulb mounted in one of the chambers -A. The cardboard divider comprises two sides, A and B. To make chamber B appear darker, install a little light inside chamber A and leave it empty in chamber B. Create small entrances in both compartments so that cockroaches can enter whichever compartment they like. Shut the box and illuminates the bulb for a minimum of one hour. Once the box is opened, count how many cockroaches are inside each section. More preference for light-coloured cockroaches, which indicates that they are photopositive. They are photonegative if they lean more toward the dark side. Repeat the experiment by altering the bulb's temperature, colour, and intensity (Plate-1).

Figure 1 The cardboard box

Figure 2 Two chambers 'A' and 'B'

Figure 3 Chamber 'A' with bulb

Figure 4 Chamber 'B' without bulb

Figure 5 Chamber with red light

Figure 6 Chamber with blue light

3. Result

By varying the bulb's intensity, the experiment was carried out in two chambers, A and B, under various conditions. Total 10 cockroaches are observed under 4 different scenarios. Each scenario was done under 3 trials at an interval of 1 hour.

Table 1 Number of experiment and trial of light intensity

Number of Trials	**First Experiment**		**Second Experiment**		**Third Experiment**		**Fourth Experiment**	
	Chamber	**Chamber**	**Chamber**	**Chamber**	**Chamber**	**Chamber**	**Chamber**	**Chamber**
	A	**B**	**A**	**B**	**A**	**B**	**A**	**B**
First trial (60 Min.)	3	7	1	9	1	9	0	10
Second trial (60 Min.)	2	8	1	9	1	9	0	10
Third trial (60 Min.)	2	8	0	10	1	9	1	9

In First experiment, the bulb was dim and the temperature was low in chamber 'A' whereas the chamber 'B' was dark. Numbers of cockroaches in chamber 'A' were 3 and in chamber 'B' were 7 in first trial. During second trial numbers of cockroaches in chamber 'A' were 2 whereas in chamber 'B' were 8. In third trial the numbers of cockroaches in chamber 'A' were 2 and in chamber 'B' were 8. The photonegative behaviour was observed as there were movement of fewer cockroaches in chamber 'A'. In second experiment**,** the bulb was bright and the temperature was high. As in chamber 'A'

the temperature was high, it was observed that during first trial only 1 cockroach was present in that chamber whereas in chamber 'B' there were 9 cockroaches present. Same numbers of cockroaches were observed during second trial. Whereas in third trial the numbers of cockroaches in chamber 'A' were 0 and in chamber 'B' were 10. It shows clear photonegative behaviour. In third experiment**,** the bulb was blue and the temperature was warm. Again, photonegative behaviour is observed as the number of cockroaches in chamber 'B' was 9 during all the three trials. In fourth experiment**,** the bulb was red and the temperature was very high. Due to high intensity of light the number of cockroaches in chamber 'A' was 0 during both first and second trials whereas in third trial only 1 cockroach was observed in chamber 'A'. Photonegative behaviour was totally observed (Table 1).

4. Discussion

The experiment was conducted under different situations in two chambers A and B by changing the intensity of the bulb (7). In situation-I, the bulb is dim & cold in chamber 'A' whereas the chamber 'B' is dark. Number of cockroaches in chamber 'A' is 2 and chamber 'B' is 8 i.e, photonegative effect was observed as there was movement of 2 cockroaches in chamber 'A'. The present experiment was conducted under different conditions in two chambers, A and B, by adjusting the intensity of the bulb. In these four instances, ten cockroaches are observed. Three trials were conducted for each situation, spaced one hour apart (Table-1).

In first experiment, chamber A had a low temperature and a dim bulb, whereas chamber B was completely dark. In the first experiment, there were three cockroaches in room A and seven in chamber B. In the second trial, there were two cockroaches in chamber A and eight in chamber B. In the third attempt, there were two cockroaches in chamber A and eight in chamber B. The photonegative behaviour was noted due to a decrease in cockroach movement in chamber A.

In second experiment, the bulb is little bright and warm because the intensity of the bulb was slightly increased only one cockroach is seen in chamber 'A' and in chamber 'B' is 9. In second experiment, the temperature was high and the bulb was bright. Due to the high temperature in chamber A, it was noted that during the first experiment, there was only 1 cockroach there, compared to 9 in chamber B. There were the same number of cockroaches seen in the second trial. In contrast, there were 10 cockroaches in chamber B and 0 in chamber A on the third trial. It behaves in a photonegative manner.

In third experiment, the intensity of the bulb was still increased. It is brighter and hot. Number of cockroaches in chamber 'A' is nil whereas in chamber 'B', it is 10. In third experiment, the temperature was warm and the bulb was blue. Once more, photonegative behaviour is seen because there were nine cockroaches in chamber "B" throughout the course of the three trials.

In fourth experiment, the intensity as well as the colour of bulb is changed to red or blue, it was observed that chamber 'A' has nil cockroaches and chamber 'B' has 10. Therefore, it was observed that by changing the intensity and colour of light, we can know the photonegative or photopositive nature of the animal. In fourth experiment, the temperature was really high and the light was red. In chamber "A," there were none in the first or second trials due to the strong light, but in the third trial, there was just one cockroach visible in the chamber. The photonegative behaviour was fully noted.

5. Conclusion

Cockroaches are photonegative since it was observed that they moved away from the light source. Cockroaches are more prevalent in that specific compartment and are photonegative. Cockroach populations in a given chamber are lower and they are photopositive. The fact that the cockroaches are avoiding the light suggests that their behaviour is photonegative.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors have no any conflict of interest for publishing this article.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study

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