The influence of LED lights on Acheta domesticus compared to the ways in which Noctuidae and Drepanidae are attracted to light.

Abstract:

The topic of this paper is various insects' reactions to purple, red, and green LED lights, for this study crickets' reactions were compared to moths' reactions. The purpose of this project was to determine if the color of LED lights that Acheta domesticus (house cricket) are shown influences the number of crickets attracted to the light, and to compare these findings to the ways in which Noctuidae and Drepanidae (moth) are attracted to light. WHile searching for background research I noticed that not many articles have addressed why this topic is important and how it can affect many species of insects and crickets. I approached this experiment knowing that if the Acheta domesticus did not like a certain LED light they would want to get as far away as possible, but I did not want to lose the crickets. Therefore, I needed to give them only two options: be directly near the light or as far away as possible, and a crickets habitat with LED lights on one side was the best way to do this. Then, I rotated the LED lights in order- purple, red, green- for 10 minutes each, with a period of darkness in between each, this was done for three trials. Man made lights have disturbed the pollination process, by interfering with insects navigation patterns. We need to maintain and better the amount of pollination plants in our environments get, we need to reduce our use of man made lights that interrupt the pollination patterns of nocturnal Insects.

Acknowledgements:

I would like to thank Dr. Archuleta for sponsoring this project, giving us so much time to complete this project, and helping us through every step. Next, I would like to thank my parents for letting me put crickets in the house and supporting me and the discoveries I made during this experiment. I would also like to thank my brother for staying out of the room with the crickets. Thank you to everyone at Sarsef and S.T.A.R Labs for giving me the opportunity to do this project.

Table of Contents:

Introduction/ Rational

The first articles I used for background information in my article discussed the life span and importance of moths as pollinators. The first of these articles came from the Journal of “Zoologia” and discusses the life span of moths and what conditions they will need to live to their full biotic potential (“Biology and life table of Dirphia araucaria (Lepidoptera: Saturniidae): A herbivore of potentially high impact on Araucaria angustifolia” by Mauricio Zenker, Alexandre Specht, Edegar Fronza, Graziela Poletto, Fernanda Marcon, Aline Formentini and Mateus Gedoz). Examples of this are how they found that female moths would live better in 25 degree celsius temperature and that would allow them to live 110-140 days. The next article, on “the Journal of Cultivated Plants" tested/ surveyed the seasonal flight patterns of moths are by using light traps and pheromone traps (“Observations on the seasonal flight activity of the box tree pyralid Cydalima perspectalis (Lepidoptera: Crambidae) in the Rhine-Main Region of Hessia”, by Erfassung der saisonalen, and Flugaktivität des Buchsbaum). Through this they found that there are two main flight patterns: in June- July and late/mid-August- October. They took surveys of the moth’s sex, color, and frequency of being in a particular area. These articles will give me the necessary background information to explain the basic actions of moths compared to what I observe.

The next two articles I used showed the way a moth’s eyes react to different levels of light and the way different amounts of light could affect their pollination. The first of these articles was posted on the journal “Ecosphere" and showed how light pollution could affect pollinators like moths, by adding light or taking away light for different groups of Nocturnal Lepidoptera (moths)(“Effects of street lighting technologies on the success and quality of pollination in a nocturnally pollinated plant”, by Callum Macgregor, Micheal Pockock, Richard Fox, and Darren Evans).They found that contrary to what they thought, artificial light (like the kind you would see at night- street lamps) did not affect the pollination process of the moths, and they were able to successfully pollinate the plant. However, this experiment did reveal that the lamp type, lighting regime, and distance from light all affected the quality of pollination. Overall, they found that this proved street lighting could affect the pollination and therefore reproduction of plants. The next article, which was posted on the journal “Insects", discussed why moths are attracted to some forms of light by breaking down the anatomy of a moth’s eyes (“Optic Modeling and Phylogenetic Analysis Provide Clues to the Likely Function of Corneal Nipple Arrays in Butterflies and Moths,” by Adrian Spalding, Katie Shank, on Bennie, Ursula Potter and Richard Constant). They looked at the eyes of diurnal and nocturnal eyes under microscopes and used 3D-optic model programs to simulate the reflection of light. One important thing they found out throughout this experiment is that one of the reasons that moths could be attracted to man-made light is because UV wavelength is present in man-made lights. This will help me to explain why my project is testable, and give an explanation to which lights the moths are attracted to and why.

The last article I used for my background research came from the “European Journal of Entomology”, and is a survey of which pollinators (with a focus on moths) visited plants in a control area (“Settling moths as potential pollinators of Uncaria rhynchophylla (Rubiaceae)” by

Daichi Funamoto and Shinji Suguria). They did this over several weeks and took surveys of both diurnal and nocturnal moths. Their goal was to understand if nocturnal moths were as important to the pollination system as diurnal moths. To figure this out they took samples of pollen grains found on moths and counted them under a microscope. At the end of this experiment, they found that nocturnal moths are just as important to pollinations as diurnal pollinators and that both nocturnal and diurnal, insects carried over 100 pollen grains from the plants. This will help me to understand and explain why this experiment is important to do.

This research is important to understand how moths are important and why we should think about the amount of light we are emitting into our environment. Moths are, especially nocturnal ones, very important pollinators because they can boost the pollination process. Moths are efficient pollinators because they do not clog the pollination process and carry just as many pollen grains as other diurnal pollinators. This research connected to my project by understanding what kind of lights moths are attracted to. That will help us further understand if our artificial light would have an effect on moths and therefore their pollination process.

This research could have social effects on everyday life, because if it becomes true that the type of light we use does affect the pollination process of moths and other important pollinators then it could be important to consider a change of the lighting we use. The amount and kind of lighting we use could negatively affect the pollination process of moths which can affect the reproduction and growth of plants that we need. Another way this might affect our lives could be beneficial, for example, much of the light we use today is harmful and contributes to light pollution. If needed, changing this light could create a better environment and would not harm the insects we need to sustain the plants around us.

*** edited on February 6, 2022**

Materials *

Materials List:

- LED lights with remote control and at minimum 3 color settings (in this case: purple, red, green)
- The Insect Habitat
- Acheta domesticus (house crickets) (live)
- Data tables (as shown above)
- Room with light control
- Food for crickets

Parent Signature:

Brian Shay 12/1/21

***revised on January 6, 2022**
***revised on January 25, 2022**
***revised December 7, 2021**

Procedures

1. The Insect Habitat was set up according to included instructions when purchased
2. A piece of rectangular cardboard was added in the middle of the habitat to block the light from one side*
3. The Insect Habitat was moved to a room with controllable lighting (able to be completely dark and light could be let in when necessary)
4. The room was given natural lighting for the Acheta domesticus (house crickets)
5. Slowly the crickets were transferred with care and according to best instruction.
6. The Insects Habitat was closed and the crickets were left to adjust.
7. LED lights were moved close to the Insect Habitat, but were not turned on yet
8. crickets have been given 30 minutes* to settle in
9. The room was darkened and LED lights were turned to 1st setting (purple)
10. crickets were allowed 10 minutes to be drawn toward or away from light
11. The crickets were counted according to how many were drawn toward the specific light color (first, purple), then this data was recorded on data tables
12. Lights were turned off for 10 minutes so crickets could re-adjust*
13. For the next three tests step 11 was repeated but with a different color (red)*
14. Step 13 was repeated (color change to green)
15. Steps 12-14 were repeated two more times (purple, then red, then green)*

Results, Discussions and Conclusions

While the crickets were in the Purple LED light, they became more active and engaged with each other more often. This reaction repeated when they were exposed to the Green LED lights. However, while they were in the Red LED lights, there was a lack of movement and interaction and they remained still for the majority of the time unless moving towards or away from light.

The outcome of this experiment helped to prove my hypothesis because it shows that crickets were drawn to the purple and green lights, which are the brighter of the two. When observing the crickets adjust to the purple light, they became more active and interacted with each other more.This was reflected in the green light and continued throughout the three trials, which showed that the Crickets were more attracted and active when exposed to bright light. This was further confirmed when the crickets showed little to no movement in the red light. The data from our experiment was compared to the background research of moths' reaction to light. This data and research supported my hypothesis by showing that crickets react to bright lights in a similar way as moths, because both are nocturnal and are drawn to the brighter lights for safety and navigational reasons.

Light could have bleed into the darker side of the cricket habitat, causing crickets to react to light on either side despite the relation/ distance to the LED lights. The constant change between light could have caused shock in the crickets and hurt their reaction time, or how they moved/ interacted with each other. The darkness could have been interrupted when opening the door of the room with the crickets. This could have made the crickets move before an accurate count of their relation to the light was made. During the red light phase of each trial the behavior of the crickets was very similar to their activity and configuration when in darkness for 10 minutes. This could be explained by crickets lack of vision when it comes to red light. Crickets can see many colors but red, especially when it is a darker red light, as used in this experiment. Moths are nocturnal insects and use the moon to navigate during the night. Therefore when brighter lights are shown to moths, it confuses their navigational patterns. Crickets are also nocturnal and show the same behavioral patterns when it comes to the brightness of light they are shown. This explains the data gathered in the three trials for purple and green light.

Nocturnal insects like moths and crickets use natural lights to navigate in the dark. However, man made lights have disturbed this process, by interfering with their instincts, interrupting the pollination process of Nocturnal Insects like moths. Therefore, if we want to maintain and better the amount of pollination plants in our environments get, we need to reduce our use of man made lights that interrupt the pollination patterns of nocturnal Insects. Furthermore, other experiments that might aid in proving this would be to compare the pollination of moths under man made light to those under natural/ moon light. This would help to demonstrate how destructive bright lights like LEDs can be to nocturnal insects behavioral patterns.

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Links for Slide Deck Background information/ images:

.-Crickets Response to Light (extra article for background research)
-image of Drepanidae (1)
-Image of Moths Around Light (1)
- Moths Drawn to Light (2)
-image of moth at night (1)
- image of Acheta domesticus (1)