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Phototaxis in *Drosophila melanogaster*

FULL-LENGTH ARTICLE

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CITATION

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Abstract

The study was conducted to investigate the phototactic response in *Drosophila melanogaster*, also known as fruit flies. *Drosophila melanogaster* were chosen for this study because they have genetic and biological similarities to humans. The study was designed to be completed over a twelve week period looking at Phototaxis, which is how light can affect the movement of organisms. The purpose of this study is to expose *Drosophila melanogaster* to light and observe their behavior. It was intended to observe the positive and negative phototaxis under the controlled environment and see how light plays a vital role in an organism's life and how it can be used for survival. The *Drosophila melanogaster* would be isolated to a controlled environment, where they will have an artificial light source to see how the organisms react and move to and from the light. Unfortunately, the fruit flies were unable to survive due to unfavorable habitat conditions. The temperatures fluctuated and the fruit flies were unable to flourish in the environmental conditions and prevented the larval from developing. Since the study was unable to be conducted, the research shifted to a literature review focusing on phototaxis and geotaxis on *Drosophila melanogaster*. Under the guidance of a mentor, students analyzed previous experiments and research to develop a comprehensive understanding of these behavioral responses.

Keywords: *Drosophila melanogaster*, phototaxis, behavior, light, survival

Introduction

Studying phototaxis and geotaxis in animals allows researchers to gain a better understanding how light and magnetic forces can affect their behavioral and sensory functions. Research in phototaxis is beneficial because it can be essential for animals finding food, mates, shelter, migration, and survival. *Drosophila melanogaster* were chosen for this experiment because of the short generation time, high reproductive rate, genetic tools and homology, behavioral assays, and biological similarities fruit flies share with humans. Fruit flies are used in many scientific experiments because of these qualities and how they can relate to behavior, neurobiology, and genetics. The purpose of this experiment was to use *Drosophila melanogaster* as an animal model for phototaxis. This experiment was designed to help future veterinary students learn and understand phototaxis in animals. The experimental phase of this study was focused on the phototactic behavior of fruit flies under a controlled light environment. Although there were minor setbacks in the experiment, the researchers examined literature and did a literature review looking at past experiments. The mentor also provided additional information and resources to help guide and allow a better understanding of phototaxis and geotaxis in animals.

Process

The process of selecting this project was to gain a better understanding of the effects of light and magnetic forces on animals. Learning more about the light sensitives and magnetic forces in animals can allow researchers to understand how genetics and environment can affect animals. Researchers can determine what factors affect mating, behavior, migration, and survival skills of insects, birds, and other species that can help the future of neuroscience, behavior, and genetics. The experiment was unable to be completed since the environment conditions in the Moye Science Hall at Barton College were not suitable for the fruit flies to survive and reproduce. The researchers completed a literature review to gain more knowledge about how phototaxis and geotaxis affect *Drosophila melanogaster*.

Project Selection

This project was selected because learning the light and magnetic factors that affect the behavior and sensory function of animals can help students in the veterinary field gain a better understanding about animal behaviors and functions. Not only is it beneficial for students but also researchers to learn how genetics and environment can impact the behaviors and sensory functions of different species. There are many ways that studying fruit flies can be beneficial in learning more about different species behavior. The sensory processes that are most commonly seen in common between fruit flies and other species are their visual pathways, neurological pathways, and sensory functions. Fruit flies were an ideal subject for this experiment because they have a short generation time, high reproductive rate, similar genetic makeup as other species, and their behavior is easy to observe. It was important to pick a subject that had a short generation time and high reproductive rate, since the experiment was conducted throughout a twelve week period. It typically takes about ten to fourteen days to complete a full generation cycle of fruit flies from egg to adult. The time required to culture fruit flies depends

on various factors such as temperature, food availability, and the specific purpose of the culture. There were multiple researchers conducting this experiment. Each looked at the different behaviors associated with geotaxis and phototaxis and compared whether fruit flies had a positive or negative response to them.

Background and Prior Work

Phototaxis is the behavioral response that affects an animal's movement based on light. The movement that can be seen with phototaxis is either toward or away from the light and it depends on what wavelength of light attracts the species. Positive phototaxis is when an animal is attracted in moves toward the light and negative phototaxis is when the animal moves away from the light. The photoreceptor neurons in the eye are what transmits information to the neural circuits in the brain, causing the animals to either be attracted or unattracted to the light (Humberg & Sprecher, 2017). Phototaxis in fruit flies provides a valuable experimental model for the studying of the genetic, neural, and behavioral mechanisms underlying light perception and response, with relevance to both basic neuroscience research and potential applications in fields such as neurobiology and chronobiology. Studying phototaxis provides insights into the sensory and behavioral mechanisms of organisms. It helps researchers understand how organisms detect and respond to light, which can have implications for fields such as neuroscience, chronobiology, and the development of light-based therapies.

Geotaxis is a behavioral response that affects an organism's movement based on a gravitational force. Positive geotaxis allows the organism to move downward toward the gravitational pull, whereas negative geotaxis is when an organism moves upward against the gravitational pull (Fedele et al., 2014). Negative geotaxis can occur due to two geotactic genes that are found in *Drosophila melanogaster*. The two genes that were found to be important in negative geotaxis were cryptochrome and pigment-dispersing factor (Bae et al., 2016). Another part of negative geotaxis that is important is pyrexia, which senses gravity (Bae et al., 2016). However, there is also an environmental factor that has also been shown that affects geotaxis in organisms. An electromagnetic field can disrupt a fly's negative geotactic ability causing them to be unable to move upward away from the gravitational pull (Fedele et al., 2014). The cryptochrome and pigment-dispersing factor genes are a part of the circadian rhythm machinery (Toma et al., 2002). Cryptochrome is a blue light circadian photoreceptor that is found in *Drosophila* (Fedele et al., 2014). The circadian photoreceptor can be found in the flies brain, which allows the fly to be on a 24-hour clock cycle (Fedele et al., 2014). Cryptochrome can also encode a conserved photo pigmented protein that moderates an element of entrainment (Toma et al., 2002). Pigment-dispersing factor encodes a neuropeptide that moderates circadian locomotor activity (Toma et al., 2002). These genes are important to allow *Drosophila* the capability to be a locomotive and move in the direction that gravity is pulling them, whether it is negative or positive.

Methods

The experimental phase of this study was focused on the phototactic behavior of fruit flies under a controlled light environment. The study was intended to be done across a 12-week period. However, there were challenges faced during this experiment. These challenges were environmental factors that would include the fluctuation of

temperature in the Moye Science Hall. Therefore, the fruit flies were unable to survive and reproduce in the unstable environment and the experiment was not able to be successfully executed. Step one of the experiment included collecting a baseline for the fruit fly behavior. The baseline would be done without light stimuli to establish a control. By finding the control, it would allow there to be a source of comparison when the light exposure trials began. However, since there were inhabitable living conditions for the fruit flies in Moye Science Hall there was not adequate data collected for the experiment. Since the fruit flies were unable to survive, it prevented any collection of data for a variety of light conditions, including changes in intensity, wavelength, and direction of light. Upon the completion of the experiment, the different trials aimed to measure the behaviors of the fruit flies in the different light conditions. Finally, the behavior data would have shown the distance traveled, the time spent in lit and unlit areas, and other applicable metrics. The data collected from this study would have shown the different responses to the variety of light conditions, while also observing the patterns that were found in the fruit flies' phototactic responses. However, since there was a fluctuation of temperatures in the Moye Science Hall, there was no data collected or no observations made. Even though the experimental phase was designed adequately, the environmental factors that were faced in this experiment prevented the experiment from being successful.

In the completion of this experiment, the data was thoroughly processed and analyzed. The data was organized and was thoroughly looked through to ensure that the data was accurate and consistent. When the data is organized, it identifies any irregularities, and then prepared for the evaluation. After the sorting of data, the researchers intended to create a statistical analysis that passed the effects of the variety of light conditions on the fruit flies behavior. This analysis would demonstrate the patterns and correlations found in the phototactic responses of the fruit flies. Lastly, the results of the data would be compared to the experimental hypotheses and existing literature. In this final step, the results would have determined the consistency of the results found within the field of phototaxis.

Outcomes

The results of the project provided an understanding of geotactic (the movement in response to gravity) and phototactic behavior (the movement away from or towards light) of *Drosophila melanogaster* (fruit flies). The key findings of this experiment showed the specific light conditions that the fruit flies have a stronger response—such as different wavelengths, intensities of light, and even magnetic fields. The information found also lines up with other research regarding fruit flies behaviors. There were several challenges that arise when completing this experiment. The Moye Science Hall was where the experiment was supposed to be conducted. However, the building had fluctuating temperatures that created an inhabitable living conditions that prevented the growth and reproduction of the fruit flies. These conditions prevented the completion of the planned phototaxis experiment, therefore, the experiment was unsuccessful. The environmental challenges that were faced in this experiment demonstrated the importance of establishing controlled experimental conditions. The research that was conducted afterwards helped gain a wider understanding of the behavioral adaptations and sensory processes that are found in *Drosophila melanogaster*.

Future Directions and Applications

Studying phototaxis and geotaxis in *Drosophila melanogaster* allows a better understanding of light sensory and behavioral adaptations found in fruit flies and other animals. It can also allow researchers to gain a better understanding in different fields, for example, genetics, neurobiology, etc. *Drosophila melanogaster* is a commonly used model to research the different sensory, motor control, and behavioral adaptations found in animals. Light sensitivity and behavioral responses found in fruit flies can also be used to study other insects or even other species, like birds and humans. The project's findings can also suggest and demonstrate how environmental changes and even light pollution can affect different species behaviors and their ecosystems. However, this project also presented many challenges and also demonstrated the need for experimental challenges to be addressed. In the future, the first step would be to find a solution to the environmental challenges that were faced during the experiment. For example, when conducting the experiment, it should be done in a controlled environment where the temperature can be regulated to help minimize outside variables that result in inconclusive results. Secondly, future researchers can expand on the idea of this project and test a variety of lights with different intensities and wavelengths. When looking at a range of light intensity and wavelengths, we can find more specific phototactic responses found in specific light sources. Researchers that conduct a similar project need to pay close attention to environmental conditions, like temperature, that can influence the behavior and the breeding abilities of the fruit flies.

Conclusion

Although the experiment was unable to be completed, this capstone project was still able to demonstrate the importance of understanding phototaxis and geotaxis found in animals. Phototaxis helps organisms orient themselves in their environment. Examples can be seen when animals use the sun or other celestial bodies as reference points for navigation during migration or daily activities. If animals did not have these senses, they would not be able to fully survive in the world. Studying how gravity and light affect the behavior of animals, allows researchers to understand why animals have particular patterns in their lifestyle. If geotaxis was not found in animals then they would not be able to differentiate between going up and going down. Phototaxis allows animals to either be attracted to or away from light depending on their lifestyle. By studying these important topics, it allows researchers to learn more about how environment and genetics affect the behavior of animals.

References

- Bae, Ji-Eun; Bang, Sunhoe; Min, Soohong; Lee, Sang-Hyup; Kwon, Soon-Hwan; Lee, Youngseok; Lee, Yong-Ho; Chung, Jongkyeong; & Chae, Kwon-Seok. (2016). Positive geotactic behaviors induced by geomagnetic field in *drosophila*. *Molecular Brain*, 9(1), 55. doi:10.1186/s13041-016-0235-1
- Fedele, Giorgio; Green, Edward W.; Rosato, Ezio; & Kyriacou, Charalambos P. (2014). An electromagnetic field disrupts negative geotaxis in *drosophila* via a cry-dependent pathway. *Nature Communications*, 5, 4391. <https://www.nature.com/articles/ncomms5391>

Humberg, Tim-Henning; & Sprecher, Simon G. (2017). Age- and wavelength-dependency of drosophila larval phototaxis and behavioral responses to natural lighting conditions. *Frontiers in Behavioral Neuroscience*, 11(66). doi:<https://doi.org/10.3389/fnbeh.2017.00066>

Toma, Daniel P.; White, Kevin P.; Hirsch, Jerry; & Greenspan, Ralph J. (2002). Identification of genes involved in *Drosophila melanogaster* geotaxis, a complex behavioral trait. *Nature Genetics*, 31(4), 349–353. <https://doi.org/10.1038/ng893>