The Effect of Type of Light on the Attraction of Nocturnal Moths

Authors: Tiarnan Smith[1] and Tristan Tran[1]
Mentors: Mary Kroll[1], Cristina Fernández-Marco[2], Sharon Pepenella[2]
[1]West Islip High School; [2]Cold Spring Harbor Laboratory's DNA Learning Center

Cold Spring Harbor Laboratory DNA Learning Center
National Institutes of Health SEPA Science Education Partnership Award
Supported by the National Institutes of Health

Abstract

Moths play an important role in the environment. They pollinate flowers and are a food source for many organisms. Moths also alert us to changes in climate and pollution levels. The increased use of artificial lighting can disturb breeding and feeding habits of moths, leading to population decline. The problem addressed was: What type of artificial light, LED or non-LED, will attract more moths and of what varieties? We observed the lights routinely and collected moths that landed near them. DNA barcoding was conducted to determine the moth species. 20 moths were collected and 15 were successfully barcoded. We found that 12 moths from 7 species were attracted to non-LED lights, while 3 moths from only 2 species were attracted to LED lights. With these results, we can provide evidence for increased use of LED lights. They will protect the health and biodiversity of moths, which will improve the overall health of the environment and people.

Introduction

- Moths are a very important part of the ecosystem. They are important pollinators of plants, which many people don't know, and are a food source for many organisms ("Butterfly Conservation" 2009). Moths are also an indicator species, so they can give us clues as to how the overall local environment is doing. They can alert us to changes in our environment, such as climate change or air pollution, which can affect humans ("Butterfly Conservation", 2009).
- A problem currently faced by moths is the increased use of artificial lights, which are leading to a decrease in biodiversity. Artificial lights can also become hot if left on for a long period of time; this can lead to moths and other insects flying into them and becoming permanently damaged. The artificial lights can also distract moths from their natural feeding and mating habits. The increased use of artificial lighting has a negative effect on the biodiversity of moths.
- By barcoding moths we can accurately identify the attraction of certain species to a type of light and discover if there has been any population that has changed because of artificial light use. Many moths look extremely similar and would be very difficult to identify as distinct species using traditional taxonomy methods (Janzen, 2005).

Specific Aims and Hypothesis

- The goal of this experiment is to find out which types of lights attract the least amounts of moths and moth species in order to protect moth biodiversity.
- It was hypothesized that if a bulb releases light in the UV, shorter wavelength, spectrum, then more moths will be attracted. LED lights do not emit any UV light so they will attract less moths ("Do LED Lights Attract Bugs?", 2016). UV light wavelengths are 10-400nm range.

Materials and Methods

Collection Method:
Moths were caught near our houses. LED and non-LED incandescent lights were used to attract the moths. Once moths gathered near the light, they were caught using a net. Any moths caught were stored individually in labeled containers in a freezer until they were transported to the school biotech research lab.

1. DNA Extraction
2. PCR
3. Gel Electrophoresis

DNA Barcoding: The moth DNA samples from PCR were sent to Cold Spring Harbor Lab for Sanger Sequencing.

DNA Subway: After receiving the results back, DNA Subway was used to analyze the moth samples' DNA and compare results to GenBank.

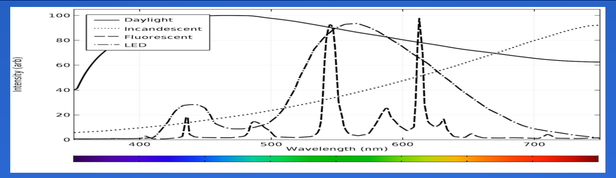

Figure 1: Light wavelength emitted from types of lights used in our experiment (Smith, 2005).

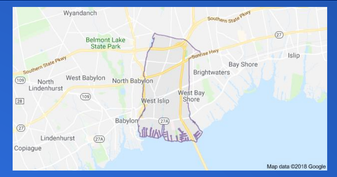

Figure 2: Moth collection site ("Google Maps", 2018).

Type of Light	BLI ID	Moth Characteristics	Align. Length	Bit Score	e Value	# Mis-matches	Scientific Name
Non-LED/14 Watts	PGZ-001	Slender Body/Brown	652	1131	0	8	*Patalene Olyzonaria*
Non-LED/14 Watts	PGZ-002	Slender Body/Brown	562	1002	0	1	*Limnephilus Submonilifer*
Non-LED/14 Watts	PGZ-003	Beige	537	964	0	1	*Limnephilus Submonilifer*
Non-LED/14 Watts	PGZ-004	Slender Body/Brown	542	978	0	0	*Limnephilus Submonilifer*
Non-LED/14 Watts	PGZ-005	Slender Body/Brown	631	1133	0	1	*Udea rubigalis*
LED/ 40 watts	PGZ-006	Small, Brown Wings/Body	655	1177	0	1	*Udea rubigalis*
Non-LED 60 watts	PGZ-007	Large body/ wingspan	660	1175	0	0	*Choephora fungorum*
Non-LED/60 Watts	PGZ-008	Slender Body/Brown	658	1187	0	0	*Limnephilus submonilifer*
Non-LED/ 60 watts	PGZ-010	Slender body, white	659	1180	0	0	*Choephora fungorum*
Non-Led 40 watts	PGZ-011	Slender body, white	607	1020	0	10	*Glenoides texanaria*
Non-LED/60 Watts	PGZ-014	Brown	671	1205	0	1	*Anticarsia gemmatalis*
Non-LED/23 Watts	PGZ-015	Brown	659	1180	0	0	*Autographa precationis*
Non-LED/60 Watts	PGZ-016	Beige	658	1187	0	0	*Udea rubigalis*
LED/ 40 watts	PGZ-017	Large body, light color	674	1216	0	0	*Mythimna unipuncta*
LED/ 3 watts	PGZ-019	Beige	658	1182	0	1	*Udea rubigalis*

Figure 5: 3 most common types of lights used (Google Images, 2018).

Figure 3: lab workspace as we prepared for electrophoresis by casting an agarose gel.

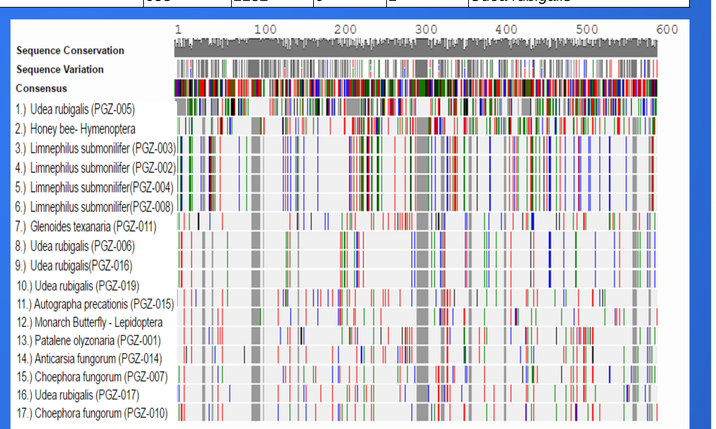

Figure 7: Shown above is the DNA barcode of our moth samples and several reference organisms.

Discussion of Conclusions

- After analyzing our BLAST results we found that 3 moths from only 2 species of moths were found to be attracted to the LED lights as opposed to 12 moths from 7 species attracted to the non-LED lights.
- This has supported our hypothesis. Through these results we can provide evidence for the idea that LED lights should be used over cheaper, yet less efficient lights. This will benefit the environment, moth biodiversity, and ultimately human health. By ensuring a habitat for moths without the unnecessary danger of lights emitting UV wavelengths, we can rely in part on moths for food and pollination of plants.
- A previous study supporting our findings is the article "Do LED Lights Attract Bugs?" which focuses on the characteristics of insect repelling lights. They stated the lights work because they emit mainly yellow 650nm light wavelengths. This wavelength is also the second most prominent wavelength in LED lights; more green 575nm light is emitted.
- In the future we would want to research the effects of CFL lights on moths because CFL and LED's are thought to be similar but are different.

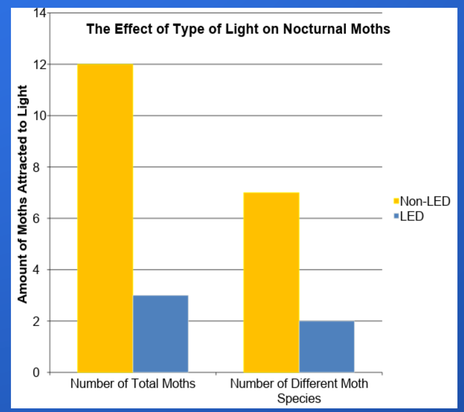

Figure 6: This bar graph illustrates the amount of moths that were collected at certain light sources.

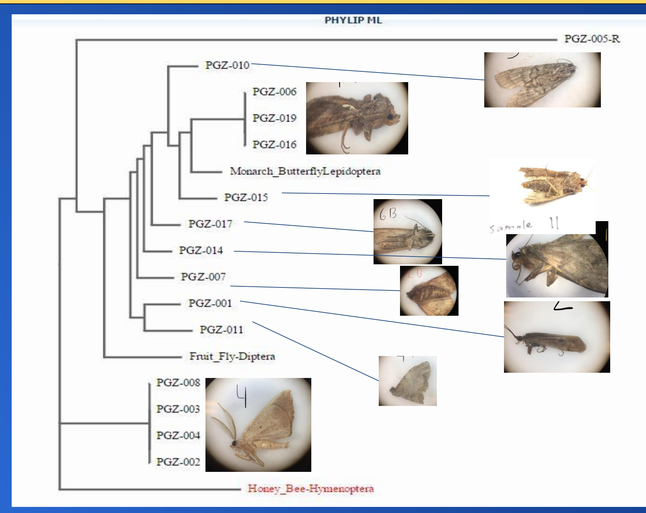

Figure 4: Phylip ML Phylogenetic Tree; this shows which samples are most closely related.

References

Butterfly Conservation. (2009, July 31). Importance of moths. Retrieved October 12, 2017, from http://www.mothscount.org/text/16/importance_of_moths.html

"Do LED Lights Attract Bugs?" *1000Bulbs.Com Blog*, 1000Bulbs, 28 Apr. 2016, blog.1000bulbs.com/home/do-led-lights-attract-bugs.

Google Images (2018), Image of commonly used lights. Retrieved from https://www.google.com/search?q=led,+fluorescent+and+incandescent+light+bulbs

Google Maps (2017), Map of West Islip NY Retrieved from https://www.google.com/maps

Janzen, D. H. (December 6, 2005). DNA Barcodes Distinguish Species of Tropical Lepidoptera. *Proceedings of the National Academy of Science of the United States of America,* 1-9. Retrieved October 20, 2017, from http://www.pnas.org/content/103/4/968.full

Smith, Daniel. "Calculating the Emission Spectra from Common Light Sources." *COMSOL Multiphysics©*, Comsol, 14 Jan. 2016.

van Langevelde, F., Ettema, J. A., Donners, M., Wallis DeVries, M. F., & Groenendijk, D. (2011). Effect of spectral composition of artificial light on the attraction of moths. *Biological Conservation*, *144*(9), 2274-2281.

Acknowledgements

We would like to thank the scientists at Cold Spring Harbor Laboratories, especially those in the DNA Learning Center, for their assistance in reviewing and approving our research. We would also like to thank all those involved in Barcode Long Island and West Islip High School for providing us with assistance to carry out our research, especially our research teacher Mrs. Kroll.