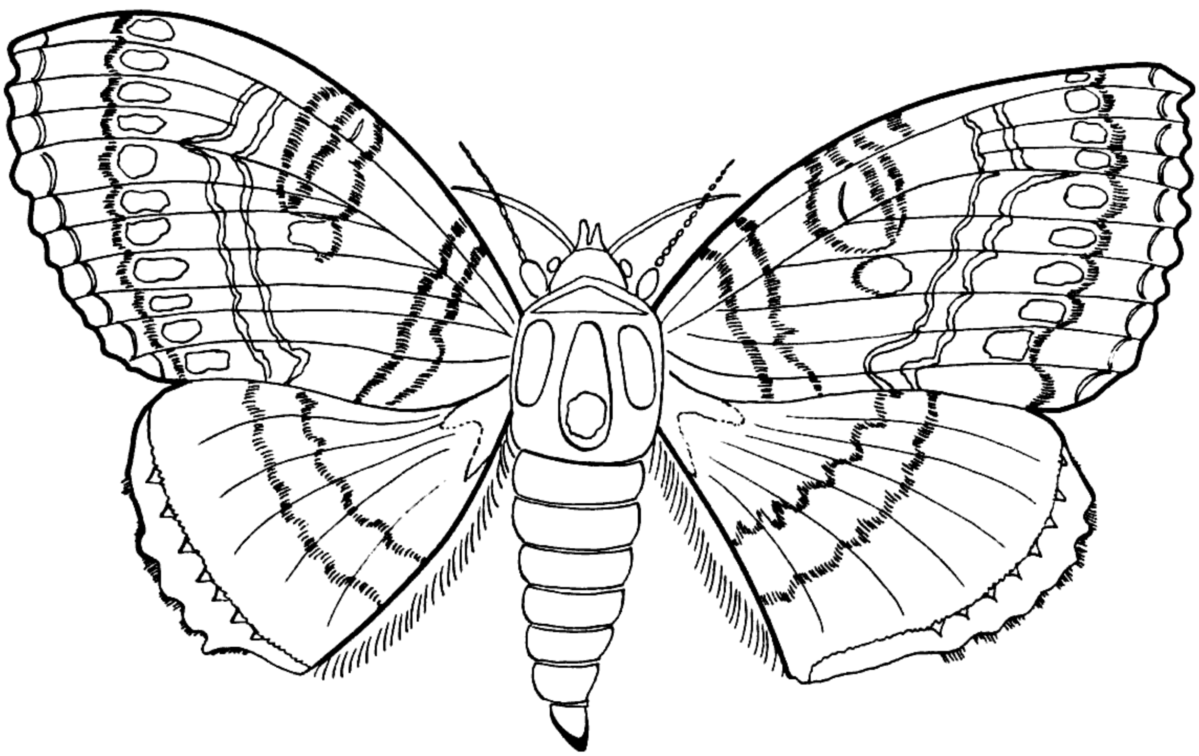
Differential Attraction of Insect Orders

to Different Wavelengths of Light



Christopher M. Hering

Field Biology and Ecology

Instructor: Dr. Michael J. Baranski

Assistant: Katie Bender

Summer Ventures in Science and Mathematics

University of North Carolina at Charlotte

August 4, 2012

ABSTRACT

The main purpose of this study was to determine if different orders of insects have different preferences for different wavelengths of light. Experiments were conducted at two different sites: in the horse trailer parking lot at Trout Lake, Cone Park, and in the backyard of the Covington lodge on Snaggy Mountain, both in Watauga County, NC. Equipment used to conduct the experiments included 25 watt fluorescent tube lights, plastic bins, water, and dish soap. The colors of the lights were red, yellow, green, blue, white, and black (UV). The lights were left on for 30 minutes in one experiment, and 45 minutes for the other one. The dish soap was mixed in with water to create a mixture that killed the insects when they came into contact with it. The dead insects were then identified, according to their orders, in a lab. A Chi-square Test was insignificant for the red and yellow light preferences, but also refuted the null hypothesis stating that there would be no differential attraction between orders to the lights. Further analysis of the data showed that the order Diptera, consistently, were the most attracted to the blue and green lights. Lepidoptera often showed the strongest preference, out of all the orders, to the black light. In total, Diptera and Lepidoptera showed the strongest preferences towards all of the lights. All of the orders except for Thysanoptera (which preferred white light) showed the strongest preference to the black light (shortest wavelength). Further study is necessary for definite conclusions about light preference between other (not Diptera or Lepidoptera) orders and would be preferred for better-supported conclusions of preference differences for longer wavelengths (red and yellow light) as opposed to shorter ones. It is concluded that Lepidoptera and Diptera's preference for wavelengths of light increases greatly as the wavelength decrease, while the other orders have a more modest increase in preference.

INTRODUCTION

The visible light spectrum consists of seven main colors: yellow, orange, indigo, violet, green, blue, and red. These colors have wavelengths of about 400-700 nanometers. Red has the longest wavelength, while violet has the shortest. White light is a mixture of all the colors in the visible spectrum (Madigan 2011). Yellow, white, blue, green, red, and black lights were used in the experiment. A black light is a light that emits ultraviolet light (wavelength of 380nm). Humans cannot see ultraviolet light.

Insects, however, can. Insects are small creatures whose bodies are divided into three different parts—a head, a thorax, and an abdomen–have 3 pairs of legs, and often times have a pair of antennae and compound eyes. There are approximately 30 orders in the class Insecta (part of the phylum Arthropoda), but only five were used in this study. The order Diptera includes mosquitos and flies. Insects in this order have one pair of wings, and mouthparts for piercing and sucking. Lepidopteras (moths and butterflies) usually have four prominent wings with overlapping scales and mouthparts for sucking nectar from plants. The order Trichoptera consists mainly of caddisflies—creatures that look like moths, have two pairs of hairy wings, and have long antennae. They have mouthparts for sucking, but do not use them as an adult, as they do not eat. Coleoptera, more commonly referred to as beetles, usually have two pairs of wings, with the outer layer also forming a hard shell around the beetle's abdomen, and mouthparts for chewing. Thysanoptera (also called thrips) have short legs and antennae and mouthparts that are made to rasp plant surfaces and suck its juices. Some thrips, however, are carnivorous (Drees, Jackman).

Is there a differential response not only by the class Insecta, but between its orders, to different wavelengths of light?

If an insect is attracted to a certain wavelength of light, then one from a different order is just as likely to be attracted to that same wavelength of light.

METHODS

Site and Conditions Description

The experiment was conducted twice, once on 22 July 2011 (E1), and again on 25 July 2012 (E2). The former was performed at 9:44-10:15 p.m. in the horse trailer parking lot at Trout Lake, Cone Park, located near

Blowing Rock, NC (Watauga County). The temperature was 74.8 degrees Fahrenheit, with 76% relative humidity and a clear sky. The experiment conducted in 2012 was performed at 9:44-10:29 p.m. in the backyard of the Covington lodge (1460 Snaggy Mt. Road) in Boone, NC (Watauga County). The temperature was 73 degrees Fahrenheit, with 88% relative humidity. The backyard was forested on two adjacent sides with hardwoods, scattered yard trees, and some scrub thickets (Liriodendron, *Pinus strobus*, Rhododendron).

Procedures

Six plastic bins were arranged in a circle with their longer sides facing inwards/outwards the center of the circle. Care was taking to ensure that the bins were flat on the ground. The bins were approximately 2-3 feet away from each other. Each of the bins was then filled with water so that the water level was no more than one inch tall. Dish soap was then mixed into the water (using our hands) in the bins to create a mixture that would kill the insects when they came into contact with it. Six 25 watt fluorescent tube lights were placed on top of each bin. The fluorescent tube lights were yellow, green, black, blue, white, and red. They were plugged into an outlet station in the center of the circle, which was plugged into an extension cord that was also plugged into the nearest outlet. The aforementioned times in the previous sub-section were for when the lights were left on (30 minutes for E1, 45 minutes for E2). Once the lights were turned off, forceps were used to transfer the insects from the bins to jars filled with alcohol. The jars were labeled with the colors of the lights. A few days later, the insects were identified by their orders.

RESULTS

Number of Insects per Order Attracted to Lights

Table 1: 2011data.

2011	Red	Yellow	Green	Blue	Black
Diptera	17	1	34	67	61
Lepidoptera	2	5	20	40	150
Coleoptera	1	0	1	12	6
Trichoptera	0	0	0	23	26
Thysanoptera	0	0	2	3	1

Table 2: 2012 data.

Diptera	5	19	49	68	188
Lepidoptera	2	7	33	7	181
Coleoptera	1	3	8	3	14
Trichoptera	0	1	0	0	3
Thysanoptera	0	0	0	12	0

Table 3: Combined 2011and 2012 data.

Total	Red	Yellow	Green	Blue	Black	All Lights
Diptera	22	20	83	135	249	509
Lepidoptera	4	12	53	47	331	447
Coleoptera	2	3	9	15	20	49
Trichoptera	0	1	0	23	29	53
Thysanoptera	0	0	2	15	1	18

Table 1 shows the number of each order of insects attracted to each color of light in the 2011 (parking lot in Cone Park) experiment, while Table 2 does the same for the 2012 (backyard of Covington lodge) experiment. Table 3 shows the two of them combined. The Chi-square Test (Table 4) shows that there is indeed a differential response between insect orders for different wavelengths of light, but only for the colors green, blue, and black; the data from the red and yellow lights resulted to be insignificant.

Table 4: Result of Chi-square test of response of orders to each color.

Red	Yellow	Green	Blue	Black
p=0.1 NS	p>0.1 NS	p=0.01 S	p=0.01 S	p=0.01 S

*NS—No Significance S—Significant

In general, light preference by order (from greatest to least) went like this: Diptera, Lepidoptera, Trichoptera, Coleoptera, Thysanoptera. Lepidoptera and Diptera were attracted to the lights far more than any other orders. Overall, the order that had the most insects attracted to the lights was Diptera (509), followed by Lepidoptera (447). The rest of the orders had no more than 53 insects attracted to the lights; there were 53 from Trichoptera, 49 from Coleoptera, and a mere 18 from Thysanoptera. Lepidoptera had the most (150) insects attracted to the black light by far (89 more than Diptera) in E1, but had 181 (9 less than Diptera) in E2. Furthermore, in total (Table 3), Diptera showed a much stronger preference towards the blue light than did Lepidoptera. In total, Lepidoptera and Diptera were, by far, the most attracted to the black light. However, while more Lepidoptera were attracted to the black light than Diptera, there were more Diptera attracted to the blue and green lights than Lepidoptera (Table 3).

Attraction of Insects to Different Wavelengths of Light

All of the orders but Thysanoptera showed a strong attraction towards the black light (wavelength of 380nm). Furthermore, in every order, there is a general trend that the shorter the wavelengths, the more insects there were attracted to it. This trend is also quite easily noticed by looking at the two extremes: while there were 249 diptera attracted to the black light (380nm), there were only 22 attracted to the red light, which has a wavelength of 650nm. In Lepidoptera, there were merely 4 insects attracted to the red light (compared to the 331 attracted to the black light). This trend continues in the orders Coleoptera and Trichoptera. However, in Thysanoptera, the white light, whose wavelength was not determined (it can vary), attracted the most (24) insects. The black light still attracted more than the red light (1, 0, respectively), but the blue light attracted 15, the green one 2, and the yellow one 0. While this is surprising, it does follow a similar trend—the blue light, with a wavelength of 475nm, attracted more than the green light (510nm), which attracted more than the red and yellow lights (wavelengths <510). The data in Table 3 was transformed into Figure 1 to give a better visual representation of the data in supporting this trend:

Figure 1: Graphical representation of response to different colors.

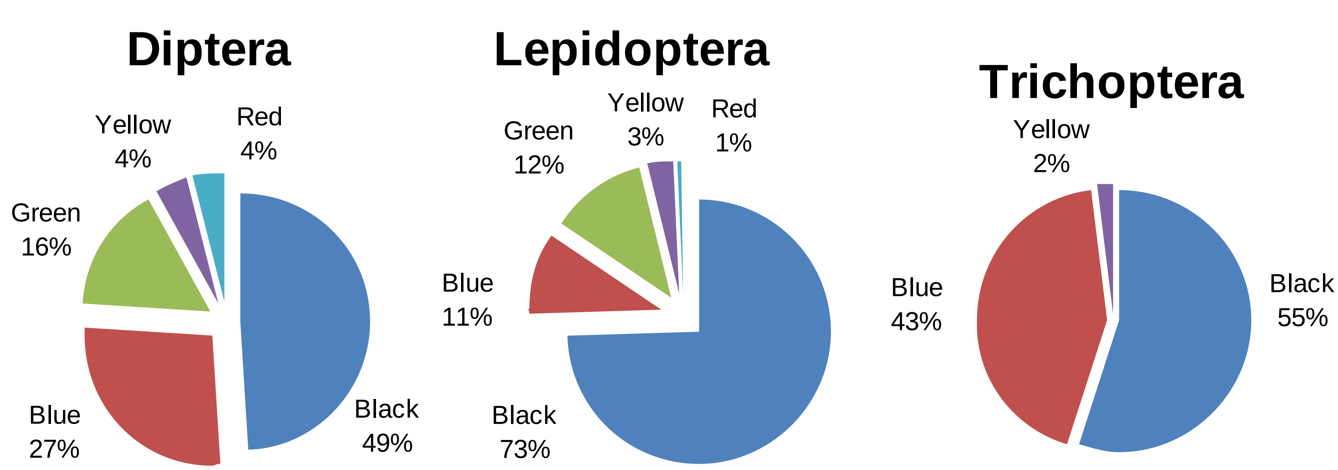
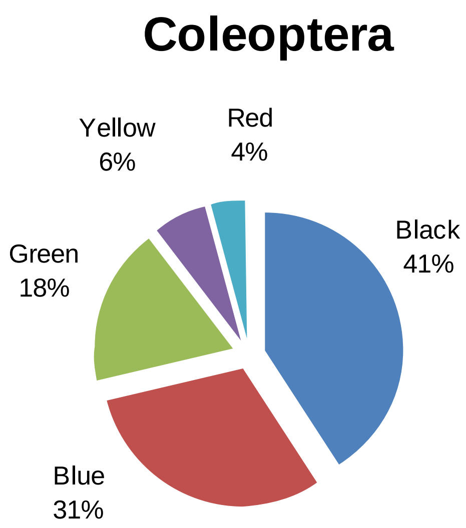
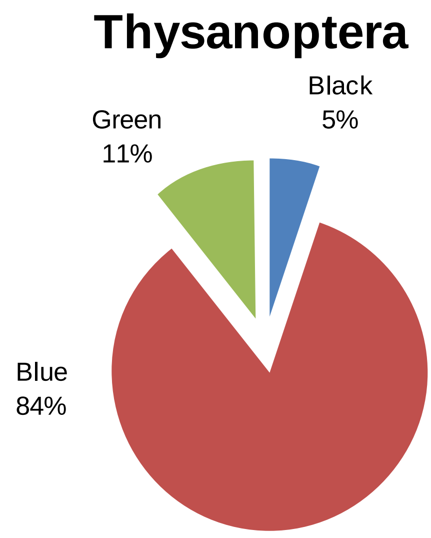


Fig 1 continued.





DISCUSSION

LITERATURE CITED

Madigan, J., "What Wavelength Goes With a Color?," NASA. Last modified November 15, 2011, <http://science-edu.larc.nasa.gov/EDDOCS/Wavelengths_for_Colors.html> (accessed 30 July 2012).

Drees, B. M., Jackman, J., "Overview of Insect Orders," Department of Entomology at Texas A&M University. <http://insects.tamu.edu/fieldguide/orders.htm> (accessed 31 July 2012)