The influence of different wavelengths on *Poecilia reticulata*

- **A Biosensors Project report**

The importance of opsins in color vision

The electromagnetic spectrum regroups all of the wavelengths of the known photons. It contains all the wavelengths from 1 pm to 100 Mm. Out of this whole spectrum, only a few wavelengths are visible by the human eye : the ones between 380 and 750 nm. We are able to see these colors thanks to a protein called opsin, found in photoreceptive cells in our retina. Most animals only have 3 opsins : low, medium and high. This is the case in humans. Fishes usually only have one or two opsins. But recent studies [reference] have shown that a certain type of fish, called *Poecilia reticulate* have up to six opsins expressed for their vision, and they are highly sensitive to long wavelengths [reference]. We got interested in knowing if *P. reticulate* preferred a certain wavelength since they have more opsins than the average. *P. reticulate*, more commonly known as « Guppy » are small fishes that measure 3 to 4 cm. They typically live in freshwater water going from 18 to 30°C . Guppies like to play or hide in small plants such as waterweed. The color vision in guppies helps them choose their mating partner, and is directly correlated to the color pattern on their scales [reference].

In this study, we experimented with 4 different lights : red, green, blue and white, red having the longest visible wavelength and blue having the shortest visible one.

Preparing for our experiment

First we needed to buy our specimens. We had initially planned on buying 20 of them but we learned that buying more than 4 at once would kill them within a week as it would disturb the biological equilibrium. We bought 4 guppies (1 male - 3 females) and introduced them to the main aquarium we used when they weren't being tested. The water was at 21°C and was being filtered by an air pump. We added Elodea in the aquarium so the fishes could play in them and poured some water bacteria that would help the guppies accommodate to their new environment. Once the main aquarium was ready, we focused on the test aquarium. We made a DIY aquarium with some plexiglass and a laser-cutter. Once all the parts were cut, we glue gunned them together and added some joint to waterproof it. The dimensions of the aquarium were 25cm * 25 cm * 20 cm. Around that aquarium, we wrapped an Adafruit LED band of 60 LEDs. We used an Arduino to divide that band in 4 equal parts, displaying 15 LEDs with a red light, 15 LEDs with a green light, 15 with a blue light and the other 15 with a white light. At the bottom of the aquarium, we drew 4 zones corresponding to the lights emitted. Now that all of our material were ready, we were able to begin our experiment.

Experimenting on our guppies

First we filled our test aquarium with water from our main aquarium so that the fishes wouldn't be too disturbed. Once the aquarium was filled, we carefully took a jar, put water in it, and gently captured one of the fishes with a net and transferred it into the jar. We then emptied the jar into the test aquarium and let the fish accommodate to its new

environment for 5 minutes. Once the fish felt at home, we started to record its behavior when the LEDs were off, using a camera. In parallel, we observe how long they spent in each zone using a chronometer. Once two minutes had passed, we turned the LEDs on and repeated the observation process (camera + chronometer). We repeated the cycle « no light - light » 3 times per fish. Once the experiment was over for one fish, we repeated it for the others until all four of our fishes had took part in the experiment . We then added all of the times per zone per fish together and compared them when the light was on and when the light was off.

We repeated the process at different moments of the cycle of the fish. First we did it during the afternoon, then we reiterated the day after in the morning, as well as in the afternoon in order to compare if it was specific to the certain time we did the experiment or the the moment of the cycle we conduct the experiment.

No significative data

We gathered data at 3 different times : afternoon, morning and afternoon once more. We decided to use two different moments of the fishes' cycle in order to try to determine whether a behavior was specific to a certain moment of the day. We also repeated the experiment twice during the afternoon because we wanted to see if there was a specific pattern that appeared to be repeating itself at the same moment of the cycle. If we observe the graphs individually, there is no apparent behavior showing that the guppies prefer a specific wavelength to another. The data shows little to no change at all in the behavior of the fish when the lights are on or off. There is also no difference of behavior in the male and females guppies. The first graph shows data from the first afternoon. The only significative change is with the 3rd guppy, that appears to spend more time in the blue zone and less in the white when the lights are turned on. The data gathered in the morning are not showing us anything significative. We will however note that the 2nd fish spent almost all of the 2 minutes in the green zone, but this fish also seemed sick so the data is not representative. The final graph shows the second set of data for the afternoon. It does show a lot of movement from all of our fishes, but the results are biased as they were taken right after we had fed the guppies. Moreover, they do not show anything significant either, except for the first fish that seems to go towards the green light, and the second fish that seems to avoid the red light. As a conclusion, we cannot say that the fishes prefer a certain wavelength to another, but we do have some ideas on how to improve our experiment and answer our question in the future.

Many perspectives

In order to further our experiment, we could make some improvements. First of all, we could increase the number of fishes we worked with. Here we could only work with one male, which is not representative to a whole population. We could also not only record how long they stay in each zone but also track their movements to see if they follow some kind of pattern. Moreover, we could try different wavelengths, higher and lower, and try to observe if they are more attracted to invisible light such as infrared. This could be possible because they usually use their IR vision in order to find their food.

Ethical concerns

As we worked with living organisms, we had to be particularly careful to their well being. This is why we had to rethink the number of replicates, and go from 20 to 4. Moreover, we needed to make sure they were treated correctly and stayed alive throughout the whole experiment, and hopefully long after that. The water was maintained at a temperature of 21°C for the whole experiment, they had food, a water pump and the pH was neutral. The male to female ratio was respected and they had plants they could play with. We did our absolute best to respect their needs and to minimize the stress we exposed them to.

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