Effect of Blue Light on Planarian Sleep

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Abstract

The presence of blue-wavelength light in the everyday lives of humans has increased drastically over the last few decades. This rapid increase in blue-light emitting devices is a problem because of their harmful effects on human sleep (Tosini 61). The circadian rhythm, also known as the "sleep cycle," is regulated by the proper amount of Melatonin secreted (Cajochen 432). However, in certain organisms, it has been shown that as exposure to blue light to the retina increases, the amount of Melatonin secreted decreases (Figueiro 1). This has shown to have negative effects on to organisms, as the circadian rhythm becomes misaligned. This study examines the effects of blue wavelength light vs red wavelength light on Planarian sleep. This study uses a variety of methods ranging from exposure to filming to speed tracking. Results show that there is no significant difference between the speed of the planaria under blue light vs red light. However, the p-value was very close to being less than .05 (p = 0.057), so perhaps with a larger sample size there would have been a significant difference.Since the prevalence of blue light emitting devices is growing immensely each and every year, there needs to be a solution to help stop the harmful effects.

Introduction

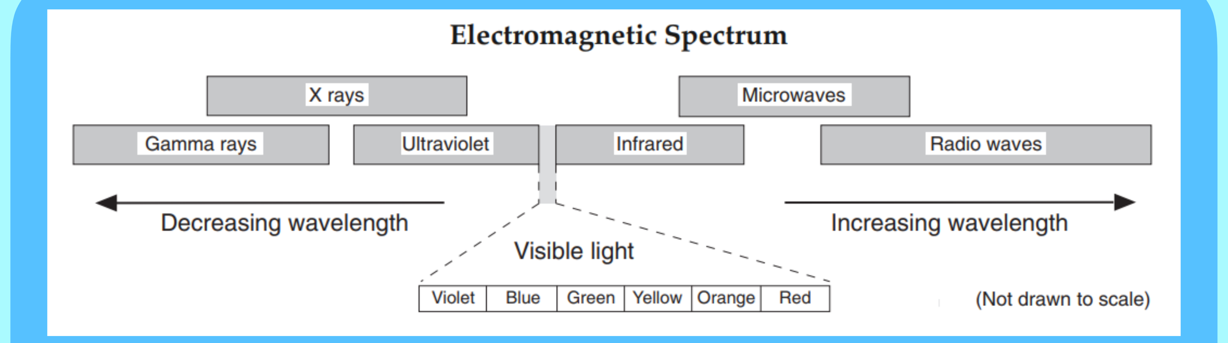


Figure 1: Electromagnetic spectrum diagram. Blue light is in the visible light section having a wavelength of 460-470 nm, and red light is in the visible light section having a wavelength of 615-640 nm.

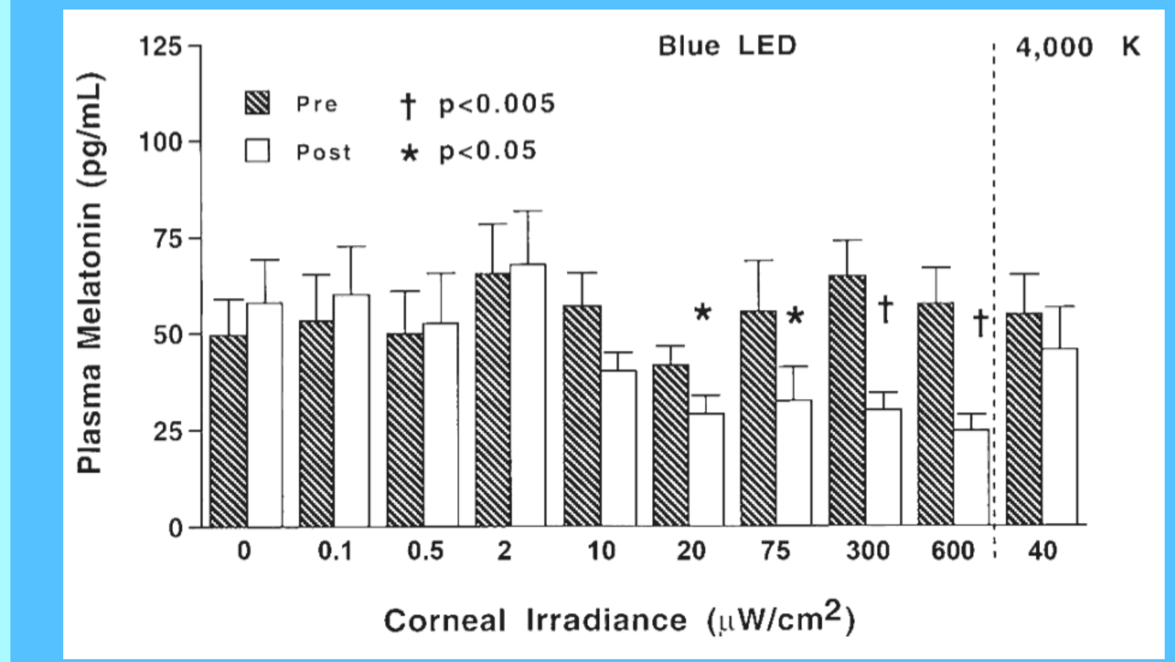


Figure 2: Data depicting the effects of increasing irradiance of blue LED light on the amount of melatonin secreted. The data shows a significant effect: as the corneal irradiance increased at and above 20 μW/cm², the amount of melatonin secreted after the exposure vs before the exposure was significantly less. This shows that there is an effects between blue light exposure and melatonin secretion in humans.

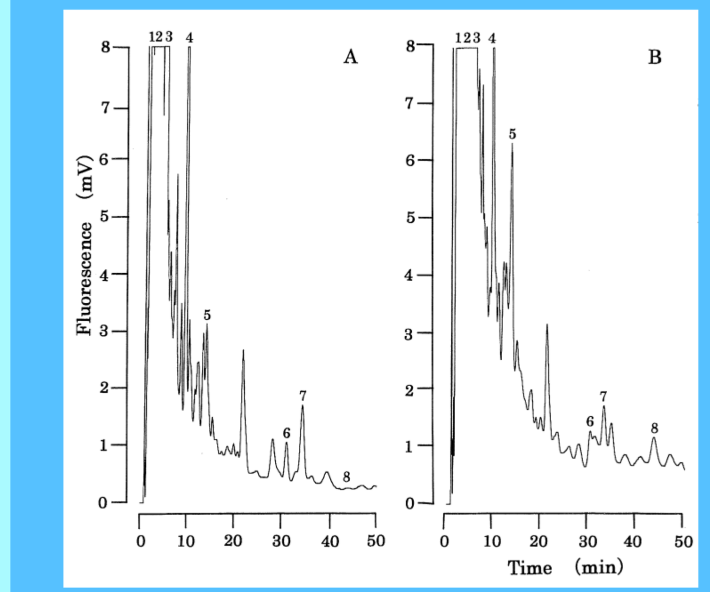
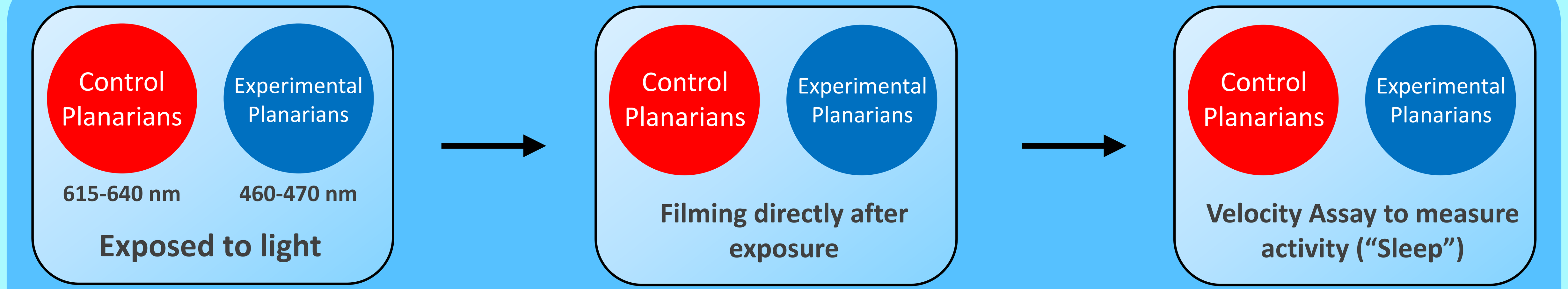


Figure 3: Data which shows the amount of melatonin secreted by planarians over a 24 hr light/dark cycle. This proves that planarians do possess melatonin levels and do possess a circadian rhythm (24 hour light/dark cycle)

Hypothesis: Exposure to blue light will shift the planarian circadian rhythm, which will be measured by a shift in their activity, or speed. There is strong evidence of sensitivity to light in planarians and there is also evidence of a circadian rhythm in planarians as well.

Methods



3 randomly selected planarians were exposed to light each night at 8:00 PM during the data collecting period for 90 minutes. This is around the time they enter their sleep period.

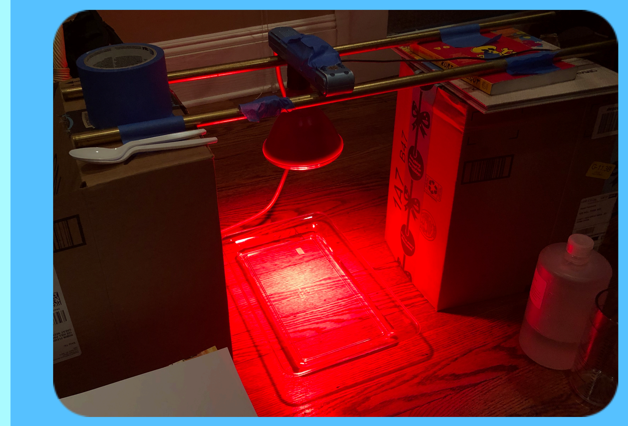


Figure 4a: Red light exposure apparatus. Consists of 1 615-640 nm wavelength LED bulb.

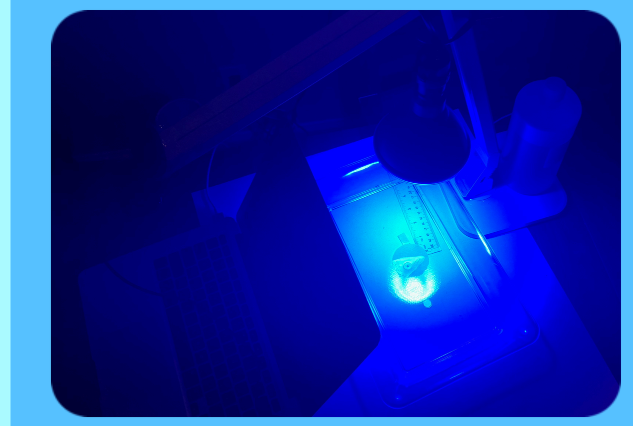


Figure 4b: Blue light exposure apparatus. Consists of 1 460-470 nm wavelength LED bulb.

Directly after 90 minutes of exposure, i.e. at 9:30 PM, the light was switched off and the camera began recording. Recordings were then saved to a hard drive for analysis.

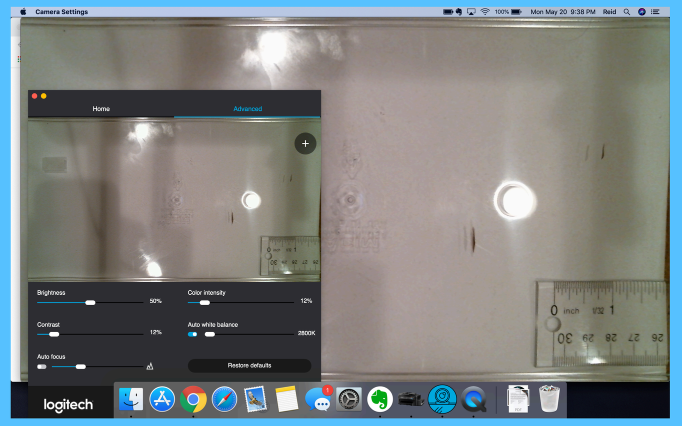


Figure 5a: Filming software: Logitech "Camera Settings" v. 2.5.12 and macOS "QuickTime Player" v. 10.5. Records 1080p at 24 fps.

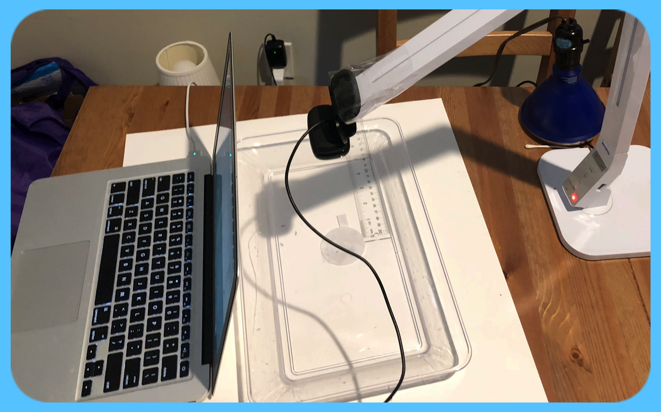


Figure 5b: Filming setup: Logitech C615 Webcam connected to an Apple laptop.

Videos were imported into the WormLab tracking software to collect speed data. Each of the 3 worms were tracked individually and the mean speed was exported.

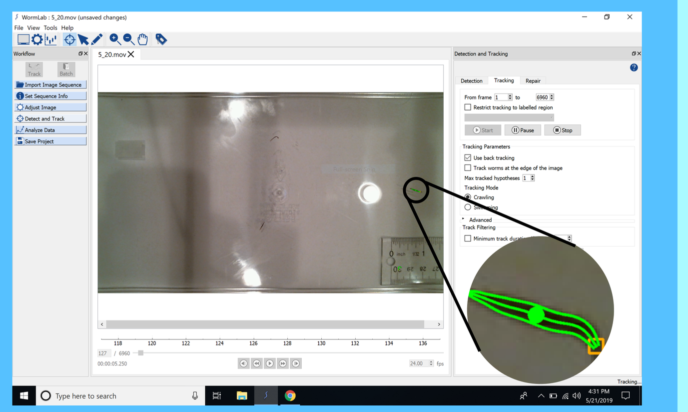


Figure 6a: WormLab tracking software calculating the speed of a planaria.

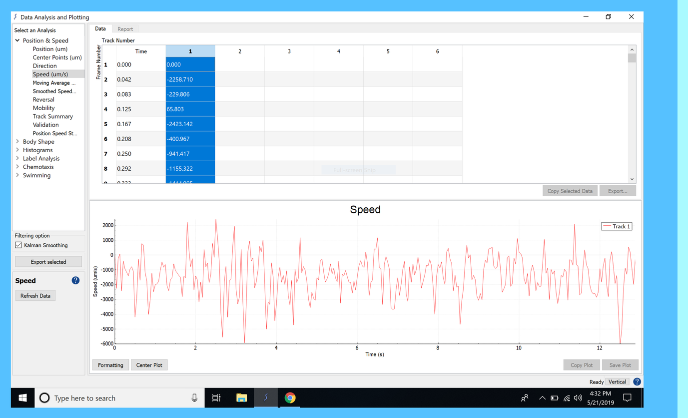


Figure 6b: Analyzing the data shown through WormLab.

Results

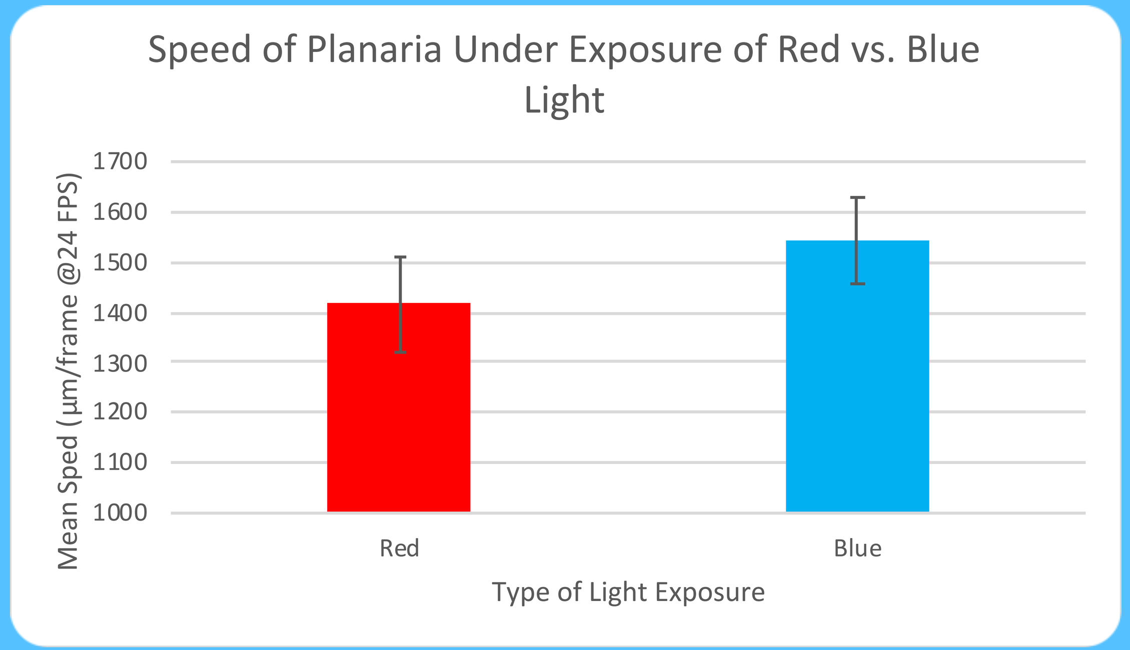


Figure 7: Speed of the planaria under the exposure of red (615-640 nm) vs. blue (460-470 nm) light. Data is expressed in mean +/- 2 SE for the error bars. n = 32 red, n = 33 blue. *There is no significant difference between the speed of planaria under the exposure of red vs. blue light (p = 0.057).*

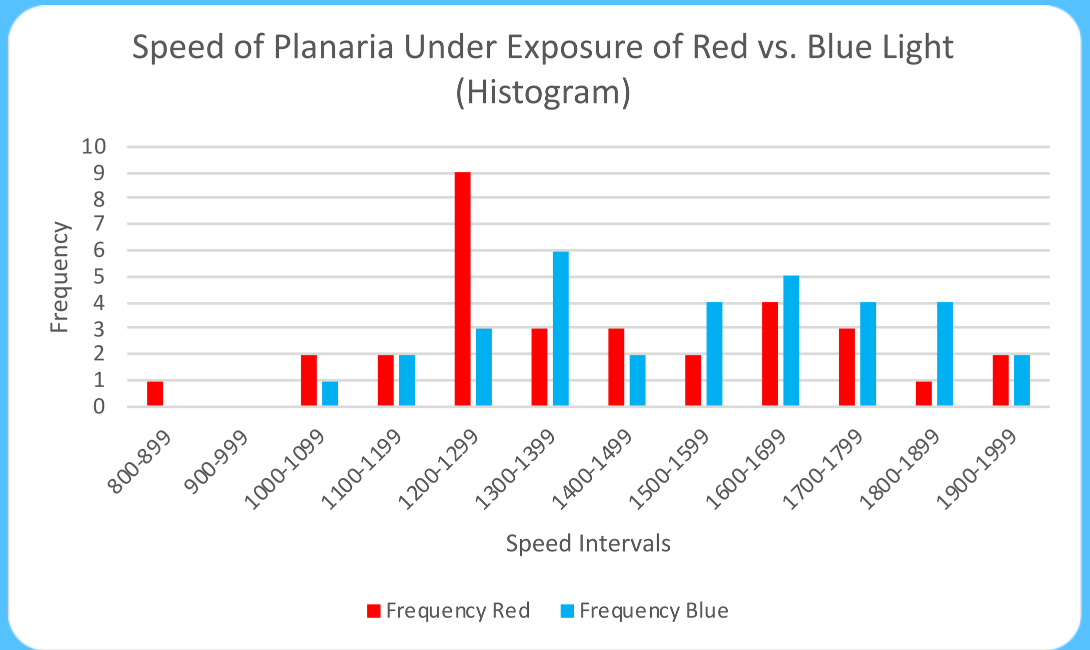


Figure 8: Frequency of speed intervals of the planaria under the exposure of red (615-640 nm) vs. blue (460-470 nm) light. Speed intervals are expressed in μm/frame at 24 fps. Each speed interval is the mean speed of each sample during the testing period. n = 32 red, n = 33 blue.

Discussion

- Goal: The purpose of the experiment was to examine the effect of blue-wavelength light on the planarian circadian rhythm.
- Since we were unable to measure the production of melatonin, which in turn affects the circadian rhythm (due to the limitations of Room 214), we decided to measure the activity of the planarians at the start of their period of sleep. This activity that we measured was their speed.
- The null hypothesis was supported based on the data. The speed of planaria treated with blue light did not show a significant difference from the speed of planaria treated with red light (p = 0.057), however it was very close!
- This indicates that the exposure of planarians to blue light does not affect their levels of melatonin, which in turn does not affect their circadian rhythm.
- However, a larger sample size could result in a significant difference as the p-value was very close to being less than 0.5.

	Mean	SE	SD	n
Red	1415.8	47.9	270.9	32
Blue	1541.1	43.4	249.4	33

Table 1: Summary of results

- Since there is a large SD and SE, there was a large variation in the data. This is likely due to slight differences between the two setups we had as well as slight differences in the tracking (some traveled in places that were easier to track by the program than others). Perhaps fixing these issues this could have resulted in a significant difference.

Future Research

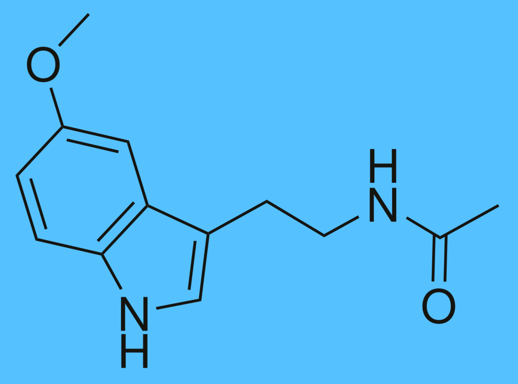


Figure 9: Structure of Melatonin

- In the future, it would be better to measure the amount of melatonin secreted rather than the activity of the planaria. This will give a more accurate result as to whether blue light shifts the circadian rhythm of the planarians.
- Other options may include tracking greater range of dependent variables to test the effect of blue wavelength light and a greater data pool may increase accuracy of the data.
- Filming of activity, as seen in this project, can also be done to supplement the above experiments.

References

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