# AN INNOVATIVE LIGHT SOURCE

## INVESTIGATING THE BIOLUMINESCENT ACTIVITY IN THE *PYROCYSTIS FUSIFORMIS* ALGA

### Bioluminescence

"Natural production and emission of light by a living organism."

### Research Question

Could the bioluminescent activity of a standardised *Pyrocystis fusiformis* algae population present an energy-efficient and sustainable light source in terms of light intensity, performance duration and recovery ability?

### Scientific Background

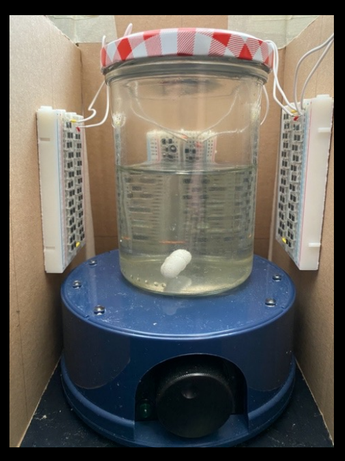
*Pyrocysitis fusiformis* are autotrophic unicellular organisms that may glow as a defence mechanism. Energy obtained from photosynthesis is converted to "*Luciferin*". At night it forms in an exergonic oxidation "*Oxyluciferin*" and emits light. External force (e.g. breaking waves) stimulates this reaction by causing an intracellular pH-drop that activates the enzyme "*Luciferase*", which in return catalyses the oxidation.

$$Dinoflagellate\ Luciferin + O_2 \xrightarrow{Luciferase} excited\ Oxyluciferin + H_2O$$

$$excited\ Oxyluciferin \rightarrow Oxyluciferin + hv(light)$$

### Measuring Device & Methodology

The built measuring device includes 4 sensors consisting of photodiodes, a magnetic stirrer, and an Arduino Uno minicomputer. It was gauged using a standard LED (*for gauging procedure refer to the research paper*).



Measuring setup from within showing 3 sensors, magnetic stirrer and algae population in beaker

Whole measuring device including 4 sensors built together, Arduino Uno minicomputer and computer. The sensors were placed in a dark box, thus no external light distorted the data collection.

### Experiment

6 standardised equally large algae populations

2 weeks of consecutive measuring nights

3 different experiments:

- Series 1: stimulation via magnetic stirrer until exhaustion, 105 seconds
- Series 2: same as in Series 1 after a 40 minutes pause
- Series 3: 30 seconds stimulation, 1 minute recovery time, 3 repetitions

On every measuring night, Population 1-3 were treated according to Series 1 & 2, while Populations 4-6 were treated according to Series 3. The obtained data was then analysed using mathematical analysis tools.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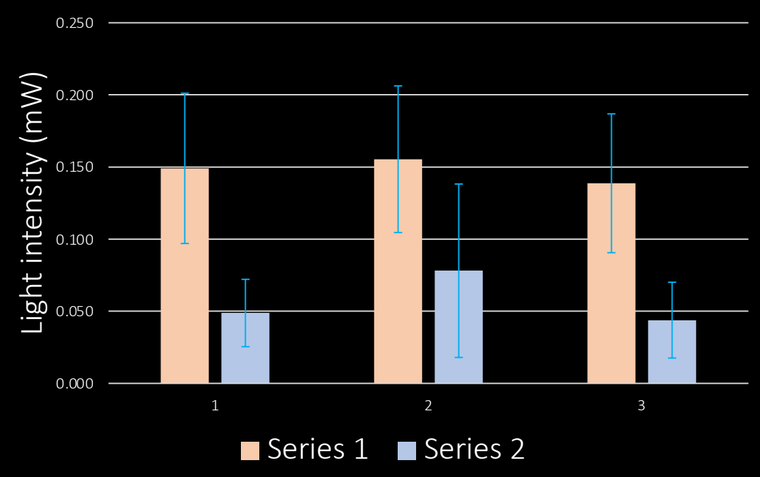
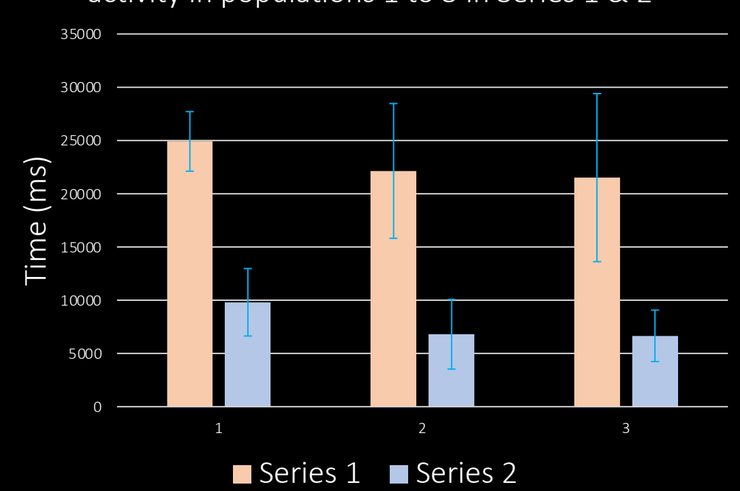
### Light Intensity

Mean maximum light intensity in milliwatt for populations 1 to 3 in Series 1 & 2



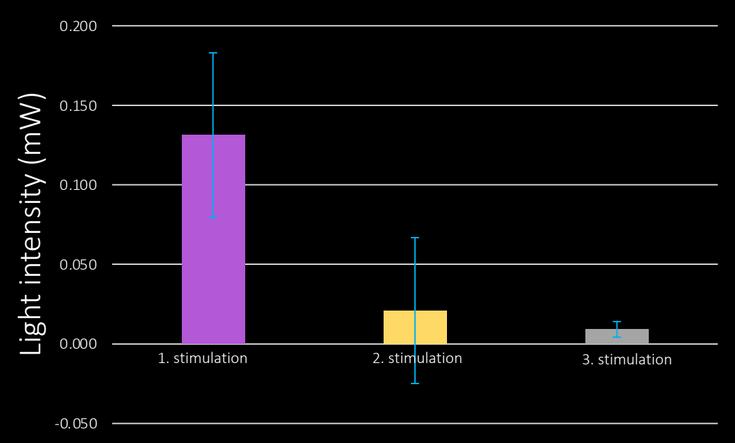

### Performance Duration

Mean relative decline in bioluminescent activity in populations 1 to 3 in Series 1 & 2




### Recovery Ability

Mean values of light intensity for populations 4 to 6 in Series 3




### Discussion & Conclusion

This investigation has successfully determined the parameters light intensity, performance duration and recovery ability. Although the research question had to be neglected due to the small values, the algae have potential and future research is needed to see whether they will one day act as energy-efficient and sustainable light sources. In summary the following was found:

- The average maximum light intensity reached 0.15 mW (*5% of a standard LED as used in gauging procedure*) and after the 40 minutes pause following complete exhaustion, it recovered to 0.06 mW.
- The light intensity reduced to ¼ of it's maximum after 22 seconds of constant stimulation.
- No recovery in 1 minute pauses was observed, but instead a rapid decline in bioluminescent activity. However, a 30% recovery of this activity was visible after the 40 minutes long pause.