Microbial Communities and Oyster Larvae Survival

**Abstract**

Microbial communities present in the water in which larval oysters grow are tied to the survival rates of oyster larvae. Initially exposing the water to X amount of UV light, which killed a significant number of microbes in the water, in mid-July led to a 7% increase in larval oyster survival. There is a potential to optimize the amount of UV light exposure, to increase the survival rates larval oysters at oyster hatcheries around the world.

**Introduction**

Microbial communities are deeply connected with the health outcomes of animals. This paper explores how the microbial communities present in the water affects the survival of the larval oysters.

In the early spring if 2021 the oyster hatchery at UMCES at the Horn Point Lab was experiencing a slowdown, meaning that their production of larval oysters was declining. It was hypothesized that this slow down might have something to do with the microbial communities present in the water where the larval oysters were growing. To test this hypothesis and get production back up to speed oyster larvae from the same brood were split between two fiber glass tanks, one was treated with UV light in the hopes of killing all microbes present in the water and one was not treated with UV light. Three days later when the two tanks were drained it was discovered that no larvae in the fiber glass tank whose water had been treated with UV had survived, whereas the fiber glass tank not treated with UV light had larvae survive at rates characteristic of the slowdown the hatchery was already experiencing.

These results indicated that the health of oyster larvae might be highly linked to the presence of certain microbial communities which would have been killed when the water was treated with UV light. From July 12th through July 15th in 2021 and experiment was run to test the hypothesis that, oyster larvae survival was impossible without the presence of certain microbial communities.

**Material and methods**

On day zero of the experiment, larval oysters for the experiment were spawned using available brood-stock. Two 600L fiber glass cones were filled with water and one cone was treated with UV light to kill microbes present in the water. Water from these 600L fiber glass cones, was transferred into six 200L fiber glass cones. The three 200L cones with the UV treated water will be referred to as, UV A, UV B, and UV C. Here A, B, and C refer to different 200L cones exposed to the same levels of UV light, not varying ultraviolet bands. The three 200L cones with the untreated water will be referred to as control A, control B, and control C. On day zero roughly three million larval oysters were transferred into each 200L fiber glass cone. Over the next four days the oyster larvae consumed an algae diet.

Water samples were taken from every 200L fiber glass cone each day of the experiment. These water samples were then used to make microscopy slides to approximate the number of microbes present in each cone. On day three of the experiment the three fiber glass cones were drained and a sieve was used to catch the larval oysters. The larvae were then transferred to bucket of 10L of water, except for UV B which was accidently filled to approximately 11.5L.

*Figure 1.*

This diagram illustrates the experimental setup. The gray bubbles represent the control group, and the blue bubbles represent the UV treated water. The arrow shows the flow of water from the 600L cones to the 200L coned used to raise larvae in the experiment.

**Results**

Microbe Survival

Chart, box and whisker chart

Description automatically generated

*Figure 2.*

This diagram illustrates the difference in number of microbes in the water for the UV and control groups. The box graphs go in order of A, B, C from left to right for each corresponding day.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Day 1 | | Day 3 | |
|  | Control | UV | Control | UV |
| Mean | 3463827 | 1250176 | 4033330 | 1592788 |
| Standard Deviation | 1007431 | 687741 | 1429703 | 509159.4 |
| Median | 3393614 | 1228722 | 4329784 | 1755318 |

*Figure 3.*

This chart shows the mean, standard deviation, and median across all three cones for the control and UV groups on day one and day 3 of the experiment.

A Welch’s two sample t-test testing the difference between mean number of microbes in the UV treated water and control water on day one gave a p-value of 2.437e-07. A Welch’s two sample t-test testing the difference between mean number of microbes in the UV treated water and control water on day three gave a p-value of 8.061e-06.

Oyster Larvae Survival

Chart, box and whisker chart

Description automatically generatedEach 200L cone started with three million live larvae. In the UV treated water the mean number of larvae that survived per cone was 1752000 with a standard deviation of 88385.52. The median number for larvae that survived in the UV treated water was 1770000 and had an interquartile range of 87000. The mean number of larvae that survived in the control group was 1543333 with a standard deviation of 61101.01. The median number of larvae that survived in the control group was 1530000 and had an interquartile range of 60000. A Welch’s two sample t-test was run to test the difference in the mean number of larvae that survived in the UV versus control groups. The test gave a p-value of 0.03376.

*Figure 4.*

This graph shows the difference in oyster larvae survival in the UV and control groups.

**Discussion**

There were fewer microbes in the UV treated water than the control. The UV light was meant to kill all the microbes in the water, but this was very clearly not achieved. The number of microbes present in the UV treated water compared to the number of microbes present in the control group were shown to have a statistically significant difference for both day one and day three of the experiment. The Welch’s two-sample t-test gave a p-value <0.05 for both days, indicating a statistically significant difference in the mean number of microbes for the UV treated and untreated water.

The larvae in the growing in the UV treated water had, on average, a survival rate that was 7% higher than the larvae in the control group. The Welch’s two sample t-test gave a p-value <0.05 indicating that larval oyster survival in the UV and control group had a statistically significant difference. The higher survival rates of larvae growing in the UV treated water were unexpected, especially because earlier in the year when the larvae growing the UV treated tank had all died.

The data does however indicate that the number of microbes present in the water, in which larval oyster are growing, affects their survival rates. The microbial community in the water might change throughout the year, meaning that the same UV exposure rate would kill different types and different amounts of microbes at different points in the year. This might explain oyster larvae survival seemed to be affected so differently by the same UV light exposure at different points in the year.

Because not all the microbes were killed when the water was treated with UV light the initial hypothesis that larval oysters cannot survive without some type of microbial community present in the water where they are growing remains untested. Further experiments should test this hypothesis by increasing the UV exposure sufficiently to kill all microbes.

Finally, this experiment indicates an exciting possibility to increase oyster larvae production at oyster hatcheries across the world. By exposing the water to UV light and only killing some microbes in the water, larvae survival rates increased. It is possible that exposing the water in which larval oysters grow to differing levels of UV light throughout the season could be optimized to increase oyster larvae production. More broadly, there may be specific characteristics of the microbe population, either the type or abundancy or microbes, that can be tuned to increase larval oyster yield. Ultraviolet light might be one variable that can be adjusted to optimize the microbe environment for oyster growth, but there may be others. The interactions between the microbe environment and larval oyster growth may be complex but the results indicate that probing this relationship with further research could have large impacts on oyster restoration efforts. This has significant implications because of the restorative properties that oysters have on the environment and the many on-going efforts to increase wild oyster populations around the world to fight environmental degradation and provide a sustainable source of protein.