Growing Algae in Wastewater to Mitigate Climate Change

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Introduction

- Algae mitigate climate change by removing atmospheric CO_2 through photosynthesis.
- Nutrient-rich wastewater is ideal for growing algae. Microbes break down the organic matter in sewage, making nutrients available.

Experimental Setup

- The Metropolitan Water Reclamation District of Greater Chicago is testing the ability of algae to treat wastewater. If results are promising, it may be implemented on a larger scale.

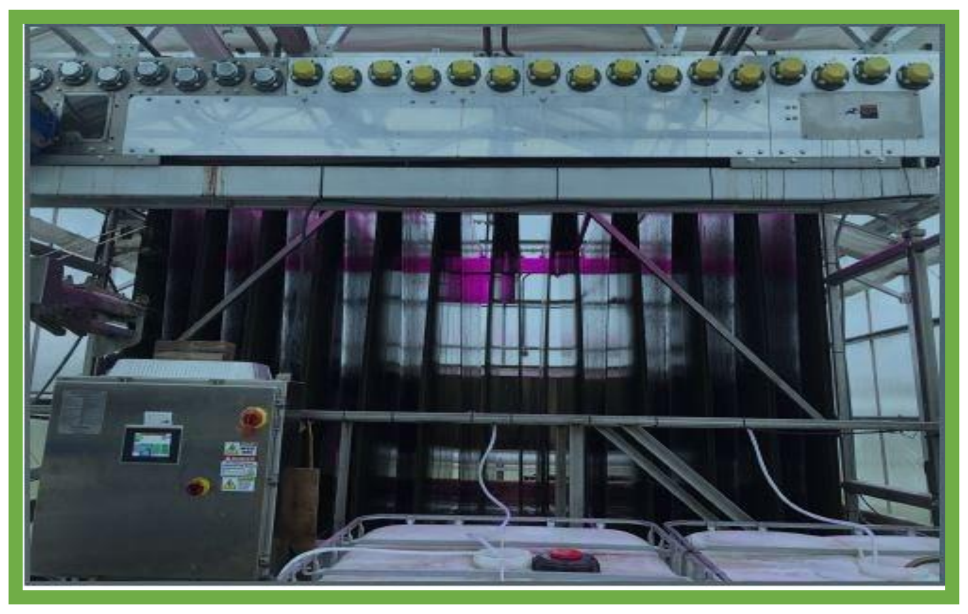

Figure 1. Algae grow on vertical 10-ft. belt at the O'Brien Water Reclamation plant in Skokie, Illinois.

- We collected samples from two algal growth systems: 1) a 10-ft vertical belt that provides a surface on which algae grow as the belt rotates through wastewater, and 2) a control pond containing wastewater and algae, but no belt.[1]
- Influent to the algal growth systems has already undergone secondary treatment;[2] effluent from each system is thus a tertiary treatment.

Results and Conclusions

- The microbial communities in the influent were distinct from those in the effluent of each algal treatment system.
- Algae growing in the control pond affected the microbial communities differently than the algae growing on the 10-ft. vertical belt surface.
- Better understanding of the relationship between algae and the microbial communities is important for wastewater treatment plants to create an environment that allows for sustainable algal growth.

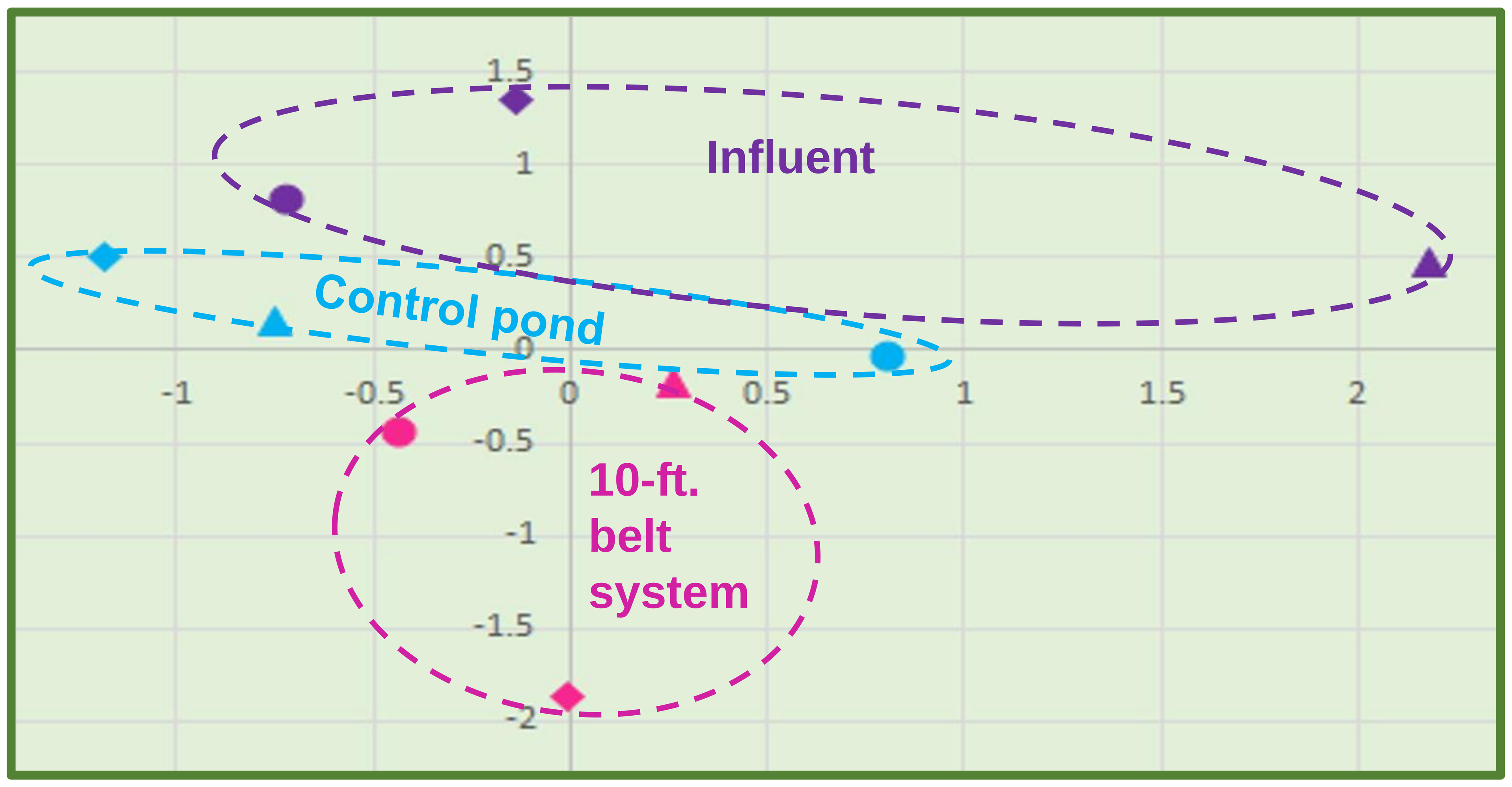

Figure 2. In Principal Component Analysis (PCA), samples that share similar microbial communities plot close to one another. Samples that plot far from one another on the graph are less similar in the microbes they contain. Samples from the influent to both algal growth systems are purple, samples from the 10-ft. belt system are pink, and samples from the control pond are blue. Triangle, diamond, and circle shapes indicate samples collected in 2021 on Jan. 13, Jan. 27, and Feb. 10, respectively.

Abstract

Wastewater provides an excellent resource for growing algae, which remove carbon dioxide from the atmosphere as they photosynthesize and thus lessen climate change. In a partnership with the Metropolitan Water Reclamation District of Greater Chicago, we are examining the potential of using nutrient-rich wastewater to grow algae. Since space is limited in an urban environment, the algae are grown on vertical belts that rotate through wastewater tanks. We have identified a wide variety of genera in the algal community, including Diatoms (e.g. *Navicula, Nitzschia, Sellaphora*) and Chlorophyta (e.g. *Scenedesmus, Chlorella, Rhizoclonium*). Because bacteria play an important role in the wastewater treatment process, we are also examining the impact of the algae on the microbial community. Preliminary results show that the algal treatment increases the types of carbon substrates consumed by the microbial community, increasing microbial functional diversity. Sewage treatment plants can benefit from using algae as a final tertiary treatment to further clean wastewater. Thus, the growing of algae in wastewater has excellent potential to be implemented on a larger scale to mitigate anthropogenic climate change.

Discussion

- Algae can be abundantly grown in wastewater, uptaking anthropogenic CO_2.
- Algae also uptake nutrients and pollutants as they grow, further cleaning wastewater. The algae can be harvested for valuable bioproducts.

Methods

- Microbial functional diversity was analyzed with Biolog EcoPlates[3] on samples taken from the influent and from the effluent of the two algal growth systems.

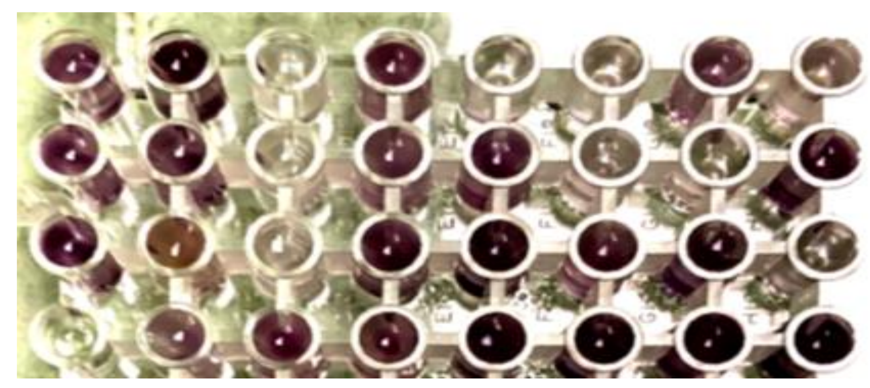

Figure 3. Darker color occurs with more microbes present to utilize the carbon substrate in a well.

- EcoPlates contain wells with 31 carbon substrates, including carboxylic and acetic acids, amino acids, and amides.
- As microbes consume the carbon, they reduce tetrazolium dye, causing a color change.

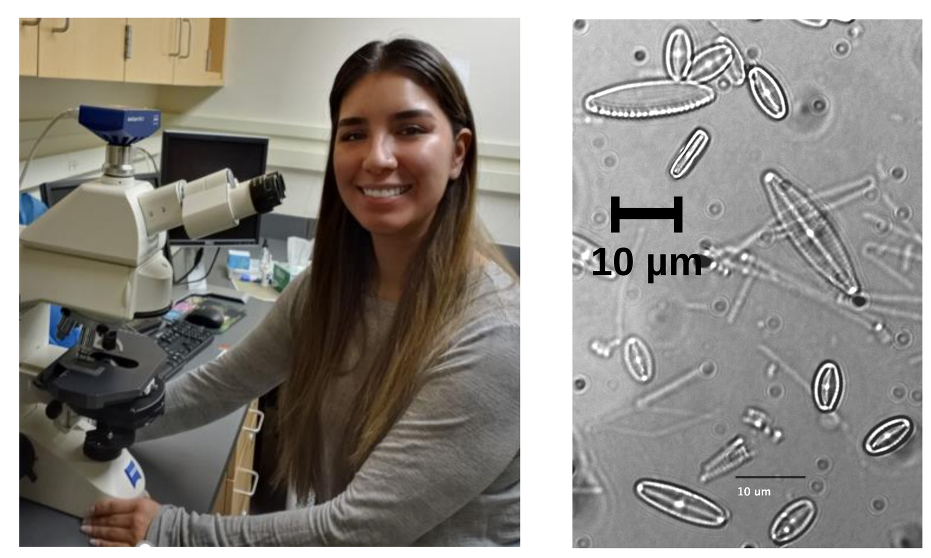

Figure 4. Our next step is to identify the species of algae growing in the algal treatment systems.

Citations

[1] Zhao, X., Kumar, K., Gross, M., Kunetz, T., & Wen, Z. (2018). Evaluation of revolving algae biofilm reactors for nutrients and metals removal from sludge thickening supernatant in a municipal wastewater treatment facility. *Water Research* 143: 467-478.

[2] Abel, P. D. (1996). Water Pollution Biology. Taylor & Francis: London.

[3] Poyraz, N., & Burcin-Mutlu, M. (2017). Assessment of changes in microbial communities in different operational units from a wastewater treatment plant. *Pol. J. Environ. Stud.* 26: 1615-1625.

Acknowledgments

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