X-Ray Study of the Elemental Compositions of the Digestive Tracts of Wastewater Microbes

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Abstract

Wastewater treatment is designed to allow the process of breaking down pollutants to occur naturally in a controlled environment. The microbes studied are Blepharisma (Protozoan), Vorticella, Euplotes (Protozoan), Paramecium Aurelia (Protozoan), Paramecium Multi. (Protozoan), Spirostomum (Protozoan), Stentor (Protozoan), and Rotifers. Studying each microbe and its structure will help us better understand the biological processes that occur when wastewater is treated. The elements in the structures of each microbe will provide an insight into the common and vital compositional elements in wastewater treatments. Research will be conducted at sector 2-ID-E using ptychography and X-ray fluorescence microscopy.

This research used resources of the Advanced Photon Source, a U.S. Department of Energy (DOE) Office of Science User Facility operated for the DOE Office of Science by Argonne National Laboratory.

Introduction

Our research started with a propitious objective of identifying and analyzing the structure and function of various aerobic and anaerobic bacteria recurrent in wastewater systems. To familiarize ourselves with the process of recycling water, a trip to a water treatment plant was a fundamental step. There are two significant categories in wastewater bacteria: anaerobic (bacteria void of oxygen) and aerobic (reliant on oxygen), both of which were utilized in the water treatment plant we toured. Following our visit, our experiment served to delve deeper into analyzing bacteria structures, such as digestive tracts. It consisted of the gathering of bacteria samples and using x-ray fluorescent mapping in the Argonne APS (Advanced Photon Source) to determine the existence and subsequently, the concentrations, of numerous elements. These elements constitute proteins and enzymes present in the bacteria that purify wastewater. The following data that we have gathered will hopefully assist in optimizing future wastewater management, a paramount yet underrated industry in today's society.

Materials and Methods

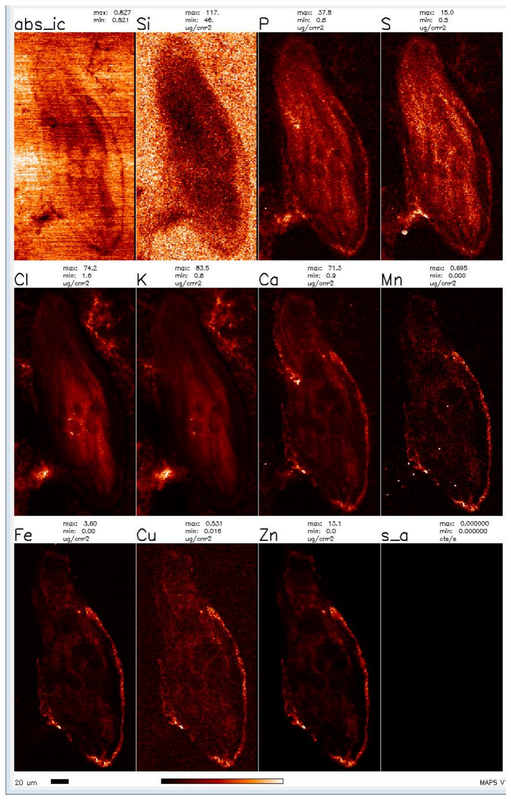
Samples:

Protozoa Blepharisma (1x1 um), Protozoa Euplotes (.5x.5 um), Protozoa Paramecium Aurelia (.5x.5 um), Protozoa Paramecium multi (1x1um), Protozoa Stentor (.5x.5 um), Rotifers (.5x.5um), Vorticella (.5x.5 um)

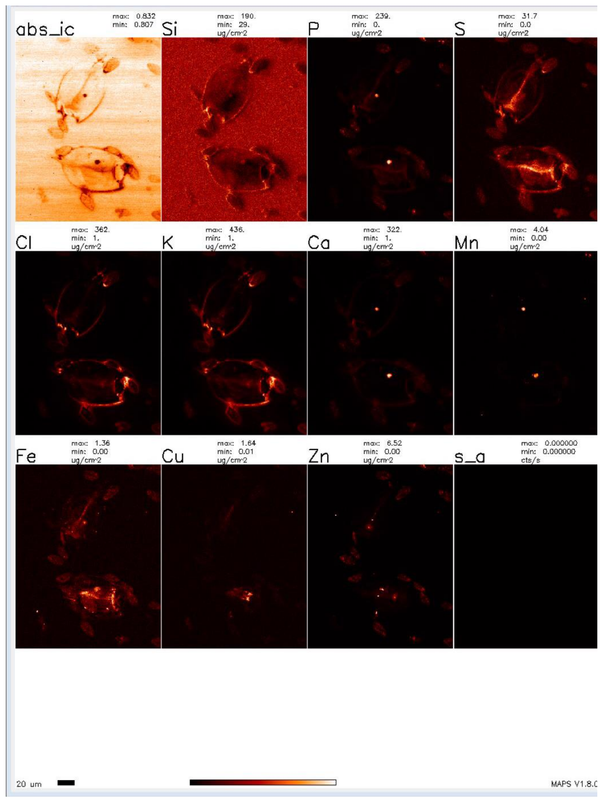
Methods:

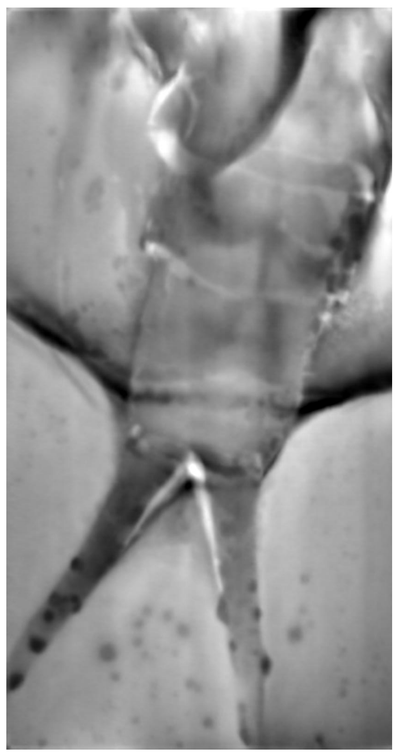
- Samples obtained from Fisher Scientific.
- Incubated, placed on silicon nitride windows with a pipet, air dried.
- Observation with regular microscope to detect portions of slides to x-ray.
- X-rayed in Argonne APS **2-ID-E**
  - FLY-Scans
  - AXO standard to eliminate the background interference
  - **PTYCHOGRAPHY** setup

Results

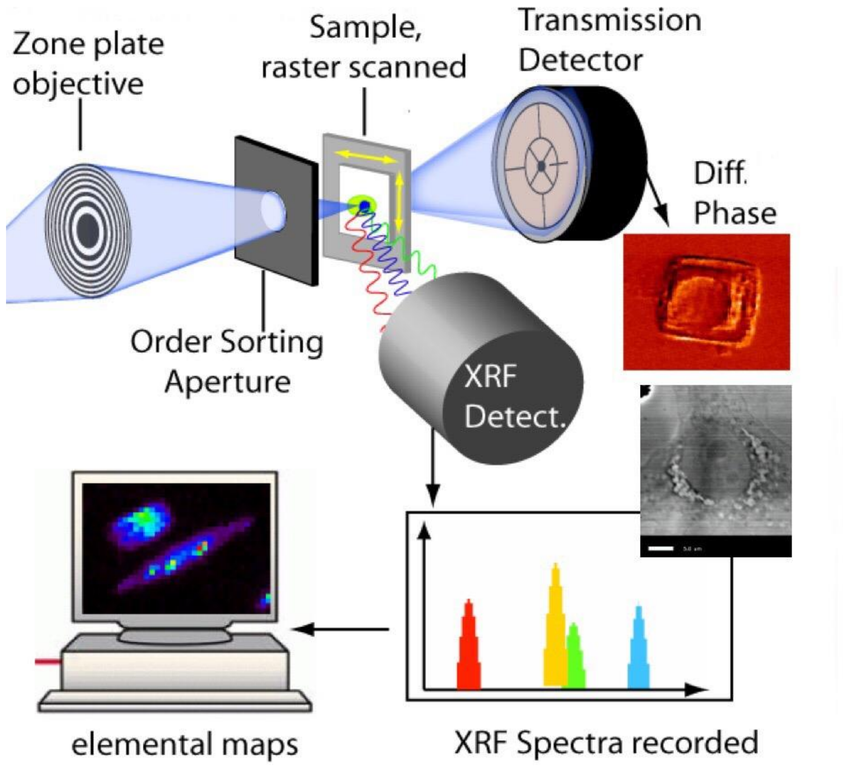


Protozoa Blepharisma





Rotifer - Ptycography



Conclusion

In an article published by "The Italian Journal of Zoology", they compile many experiments including protozoa in the waste treatment cycle. They tend to only mention what the effects protozoa have on the water but do not really delve into why protozoa are so efficient in a waste treatment plant. In this experiment we sought to find what elements in protozoa make it one of the integral parts in cleaning waste water. This experiment was successful in the fact that we were able to identify the concentrations of different elements within each microorganism. This data was reinforced by the sheer amount of data we received. The majority of the bacteria we used did not die, and the ones that did were only lost because they weren't good candidates for the trials we experimented with. However, a follow up study we could do is to test which bacteria survived the best and why the were so strong. Since some bacteria worked much better than others the aforementioned study would allow us to select viable candidates for future experiments.

Summary

In this experiment, we measured the concentrations of certain elements in the organelles of various wastewater microbes. We used the data to specifically determine the elemental compositions of the digestive organelles of these microbes, seeing how factors such as multicellularity and unicellularity affect the elemental compositions of the organelles.

Citations

"The Italian Journal of Zoology", https://www.tandfonline.com/doi/full/10.1080/11250000903373797, http://www.environmentalleverage.com/Stentor.htm, https://www.microscopyu.com/gallery-images/euplotes-protozoan-videos http://www.microscopy-uk.org.uk/mag/indexmag.html?http://www.microscopy-uk.org.uk/mag/wimsmall/cilidr.html http://www.biology-pages.info/C/Ciliates.html

Future Plans

This was just a pilot experiment to determine the presence of certain compounds in the tested microorganisms. With the results of these experiments, future testing may include introducing various food sources in order to find the most effective method of sustaining the organisms. Other possible experiments involve growing the organisms in their ideal conditions before adding various elements to their environment to test their durability.

Acknowledgments

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