

LDWS Final Report

Dec 15, 2023



Delaware River Micro-Safari: Life on a Submerged Leaf.



Introduction

This class explores the diversity of freshwater microbes on decaying leaves associated with riparian zones bordering the Delaware River and nearby tributaries. It complements the SPLASH macros and aquatic food web classes and introduces students to the microcosm associated with decomposing leaves. Through technology afforded by smart phones adapted to compound microscopes, students can go on a “Micro-Safari”, hunting for the tiny organisms that thrive on submerged leaves. They learn that decomposition releases vital nutrients into the aquatic ecosystem nourishing organisms including the same riparian plants that produced the leaves. They also learn about the importance of heterotrophic microorganisms in the food web: macroinvertebrates eat micro-invertebrates, and micro-invertebrates eat the protozoans, and protozoans eat the algae, fungi, and bacteria. Finally, they learn one reason why riparian trees are so important!

Surprisingly, I have yet to uncover studies of the microbes associated with submerged leaves in the littoral zones of the Delaware River. However, there is extensive literature on protozoans associated with freshwater ecosystems. These references (see pp. 4 -5) include identification keys and ecological studies. In several cases, the authors explore the microfauna associated with leaf litter from different tree species



(Santchi, et al., 2017) and recognize that leaves decompose at different rates, depending on the species (Alliance for the Bay, 2022, see link).

Materials

Decomposing Leaves
Cultures*
Compound Microscopes
Smart Phones
Smart phone adapters
Depression slides and coverslips
Kim wipes, Lens paper, pipettes, dissecting needles
Petri dishes
Sample vials
Micro-Safari Keys
Lesson Plan

Methods

Collect submerged decomposing leaves from the littoral zone of the Delaware River and surrounding tributaries. Seasonal differences should be evaluated. Place leaves and some water in labeled Petri dishes. Petri dishes should be stored in a cool environment under indirect lighting. Successive samples can be taken to identify changes in the assemblage of microorganisms. Leaves can be incubated in petri dishes for this purpose. Use a pipette to remove microorganisms clinging to the leaves. Place a droplet on a flat or depression microscope slide and cover with a coverslip. Protoslo can sometimes be mixed into the droplet to hinder motility in swiftly moving microbes, although there are some that do not thrive in Protoslo. Examine samples at magnifications up to 400x. Identification is expedited using books and other reference sources, although an internet search can be a quick way to narrow down the species. I found the book entitled "How to Know the Protozoa" (Jahn, et al., 1979) to be very useful. A good quality microscope camera should be used to prepare photomicrographs.

A PowerPoint slide show was prepared for schoolteachers and other group leaders to present to their students in advance of the SPLASH Micro-Safari class. Metrics are now being used to measure student knowledge prior to and class.

For class, SPLASH instructors introduce the Micro-Safari concepts and how to use the microscopes with cell phones and adapters (see attached lesson plan). Either the instructor or the student can prepare the slide for students to observe. Students are encouraged to take photos and videos with their smart phones. These images are then catalogued and uploaded to Google drive for teachers and group leaders to share the photos with their students for a post-class review. If time permits, students may collect samples and prepare their own slides. This may be most appropriate for outdoor classes. For younger students, when time is limited, microbes can be purchased from Carolina Biological Supply. This makes it easier for kids to find the microbes and identify them with the key. Thus far, representative organisms include Water Bears (Tardigrades), *Paramecium*, Rotifers, and Eel Worms (Nematodes). Additional organisms could include species of *Didinium* (predator of *Paramecium*), *Vorticella*, and *Stentor*. We also suggest including representative species of algae to demonstrate the importance of primary producers that reside on decomposing Based on our experience with our pilot classes, we have decided to create stations where

students can rotate from one microscope to the next. This will afford an opportunity for kids to learn about distinguishing features of each microorganism.

Results

I identified more than 25 different kinds (and in some cases, species) of micro-invertebrates and protozoans on decaying leaves collected at streamside locations, along the Delaware River and Alexauken Creek. Site to site and seasonal differences were observed for the Delaware River and Alexauken Creek collection sites. Physical properties associated with each site may influence assemblages. For example, on one occasion, leaves were devoid of microbes at the Delaware site but teeming with life at the Alexauken Creek site. The leaves at the Delaware site were coated with grit associated with a recent storm which may have precluded colonization by microbes. I also observed changes in the assemblage of microorganisms over time both seasonally and with extended incubation periods. Photomicrographs were obtained either from my own work or from the internet.

A draft key of 22 different microorganisms was created for use in our two Micro-Safari trial classes held at the Kingwood School on June 5th and Dec. 5th 2023. On both occasions, we rotated the students between the complementary Micro-Safari and Macroinvertebrate classes. Thanks to the assistance I received from Buddy LoBue and Eric Clark, the classes were wildly successful. It was difficult to pull the kids away from the microscopes and critters they were observing! We now have a collection of photos and videos they took of the microbes.

Discussion

Field Work.

I plan to collect more leaves from the Delaware River and Alexauken Creeks to identify the impact of cold weather on microbe populations. My hope is that we can collect leaves any time of the year (except during the winter or inclement weather) for our students to enjoy an exciting Micro-Safari. I expect that autumn leaf litter will yield a greater number and more diverse assemblage of microbes. A species list will continue to be updated as information unfolds.

Photomicrographs

I am currently using an OptixCam Summit Series USB 2.0 attached to an Omano compound microscope. The camera is very disappointing though and difficult to use. I found that cell phones attached to the microscope take better pictures. Original photomicrographs as well as images sourced from the internet were used to prepare a picture key (see lesson plan attached). The Micro-Safari Picture Key includes many of the organisms that I observed on the leaf samples. An updated picture key is being compiled.

Lesson Plan

A lesson plan has been developed for SPLASH instructors that covers the basic background information and methods needed to teach the class (see attached). The key developed for the lesson includes pictures of organisms that have thus far been identified. There is also a data chart for kids to record their observations.

Equipment

We have purchased five SvBONY LED microscopes and they are surprisingly well made, considering that each one cost ~\$100. The microscopes have a moveable stage and the necessary optics for observing the Micro-Safari critters. They are small and do not require a power supply, which is huge for us. We have been toting



four heavy, electric microscopes, along with a portable power supply for use outdoors. The fifth microscope is portable but doesn't have a moveable stage. They all work just fine, but having the five identical SvBONY LED microscopes will make the experience much better for everyone.

We also purchased five adaptors for the SvBONY LED microscopes and a refurbished iPhone (1st generation) and are evaluating it with the hope that each microscope will be equipped with identical phones like this (additional phones will cost \$296). We have been using a mix of Samsungs, iPhones, Pixels with variable ability to hold a charge.

Pilot Classes

We had originally planned to host an in-person pilot class with adult students, but instead took the opportunity to do two trial classes at Kingwood School. We have trained several volunteers to teach the class. Next Spring, the Micro-Safari class will be included in our teacher training event.

Intern

We have advertised this position at Princeton University, College of New Jersey, and Delaware Valley College but it has yet to be filled. We hope to have several students work with us in 2024.

Summary

The Delaware River Micro-Safari: Life on a Submerged Leaf class has been a great success. The children have been awed by the diversity and complexities of the tiny microorganisms uncovered in a drop of decaying leaf matter. We are happy to have all the necessary resources now to continue teaching this exciting class.

Many thanks to the Lower Delaware Wild and Scenic Counsel for helping to build the SPLASH curriculum. Your kind support has opened the unseen world of microbes on a decomposing leaf!

References:

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- Warren, Alan., F.G. Esteban, and B.J. Finlay. 2016. In: “Thorp and Covich’s Freshwater Invertebrates(4th.Ed)”. Pp 5 – 37.

Useful Websites

- <https://knowablemagazine.org/article/living-world/2020/life-springs-dead-leaves-streams>
- <https://rsscience.com/microscopic-organisms-pond-water/>
- <https://www.allianceforthebay.org/2022/12/fallen-leaves-a-trees-gift-to-the-stream/>
- https://en.wikipedia.org/wiki/Food_web
- <https://tanninaquatics.com/blogs/the-tint-1/101671233-leaves-in-the-long-term-should-the-stay-or-should-they-go>

Project Budget Summary

Expense	Balance LDWS Only	Balance LDWS & SPLASH	Total Spent (April - Dec 15)	Total Budget for Project	Total LDWS Budget	Total In-Kind Budget
Contractor Services: @ \$ 27/hour	\$108	\$1,108	\$3,092	\$4,200	\$3,200	\$1,000
Intern @ \$500 per semester (x2): <i>NOT SPENT but search cost money</i>	0	\$1,000	\$0	\$1,000	NA	\$1,000
Teacher Training Events (Kingwood)	\$0	\$0	\$300	\$300	\$300	NA
Contractor, Intern, Teacher Training	\$108	\$2,108	\$3,392	\$5,500	\$3,500	\$2,000
Travel: Approx. 768 miles @ \$0.625/mile	\$358	NA	\$122	\$480	\$480	NA
Project Expenses: Including, but not limited to the supplies (listed below).	(\$99)	\$516	\$1,119	\$1,635	\$1,020	\$615
Balance	\$367	\$2,982	\$4,633	\$7,615	\$5,000	\$2,615
Balance SPLASH ONLY						\$2,248

ITEMS	Balance	Total Spent	Total Budgeted	LDWS Budget	SPLASH Budget
SVBONY SV601 40X-1600X Microscope Compound Monocular Microscopes x 5 units First = \$106.61, Remaining Four = \$346.47 with discount = \$453.08	\$376.90	453.10	830.00	215.00	615.00
One iPhone with Charger @ \$78/unit. <i>Need 4 more (plus \$296)</i>	222.26	77.74	300.00	300.00	0.00
Five units-Cell phone shades for microscopes- @ \$35/unit NOT NEEDED	175.00	0.00	175.00	175.00	0.00
Five units- Microscope Smartphone Camera Adapter for Microscope Eyepieces @ 26/unit- \$19.99 + \$1.32 tax = 21.31 x 5	23.00	107.00	130.00	130.00	0.00
Miscellaneous Costs (shipping, books, supplies, cultures)					
through July 2023		77.74			
through Dec 2023		107.17			
Total Misc Costs	15.09	184.91	200.00	200.00	0.00
Total for Equipment and Supplies	812.25	822.75	1,635.00	1,020.00	615.00
Total with additional iPhones (\$296)	516.25	1,118.75	1,635.00	1,020.00	615.00

Micro-Safari class with the Kingwood School 5th Graders (December 5th, 2023)



Buddy LoBue is a great Micro-Safari teacher!



A child uses the key to identify a nematode.



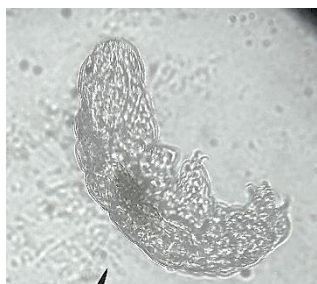
Children using the SvBony Microscope



Rotifers (x400)



Paramecium (x 400)



Tardigrade (x 1000)



Nematode



SvBony Microscope with iPhone