**Food Chain Dynamics**

Teaching Notes and Implementation Reflections

Jessica Joyner & Anna Petrovicheva

*Course Background*

The module was implemented in an introductory Ecology course with a mix of Biology and Sustainability majors, most students were upperclassmen. The class was divided into 9 groups with 3-4 members in a group. The open teaching lab was utilized to facilitate the lecture-based course to complete this lab. Students were encouraged to hold either the brine shrimp or algal population constant and to have at least 3 replicates for their experimental groups.

*General Learning Goals*

* Understand the structure and function of different trophic levels in food chains
* Develop skills to design, conduct, and complete an experiment with live organisms
* Develop data collection, analysis, interpreting, and reporting skills.

*Ecology Focused Objectives*

* Predator-Prey Dynamics
* “Bottom-up” or “Top-down” influences on an ecosystem (e.g., nutrient enrichment, predator introduction)

*Botany Engagement*

* “Bottom-up” or “Top-down” effects in a simplified food chain
* Roll of plants as primary producer

*Quantitative skill focus*

* Basic calculations and graphing - specifically population growth standard curves and cell concentrations
* Experimental design - importance of replication

*Materials needed*

* Brine Shrimp (*Artemia* sp.) culture (brine shrimp hatching supplies, artificial seawater, air pump)
* *Platymonas* sp. culture (Carolina biological supply, algal food, artificial seawater)
* 6L of Artificial seawater (ASW, Instant Ocean)
* Sterile jars for microcosm (9 groups x minimum 6 jars/group)
* Dissecting scope (& magnifying glasses)
* Spectrophotometer (including cuvettes)
* Serological pipettes or disposable Pasteur pipettes
* Loops
* Labeling tape and permanent markers

*Preparation*

De-capsulated the brine shrimp:

Materials – cysts, container with aerator, chilled bleach, NaOH, Vinegar

1. Hydrated the cysts in tap water for 1-2 hrs
2. Added chilled bleach (equal parts, 1:1 with tap water) to suspended cyst solution
3. Then added a 1:4 parts of NaOH (e.g., 100mL for 200mL H2O and 200mL Bleach)
4. Once cysts were orange (transition from brown to gray to white to orange) they were rinsed through a brine shrimp net
5. Cysts were returned to container with about 500mL tap water and 15mL of vinegar
6. Rinse cysts through brine shrimp net with tap water
7. Store in 32-37 ppt ASW

Sub-samples of algae culture with verification of standard growth curve

Pre-filled the student jars with 90mL of ASW to expedite student time setting up experiment.

*Student Assessments*

Before the students began setting up their experiment, a few poll questions were asked. About half of the class responded with general understanding of how to measure optical density and the purpose of a spectrophotometer as well as the potential population dynamics of brine shrimp and algae.

The purpose of the questions was to evaluate if they had prepared and read the protocol and reviewed the other background material the protocol cites. Additionally, to see what their initial understanding of the trophic cascades in an ecosystem. The environmental conditions question was a good lead into the experimental design, to talk about additional variables they could manipulate or that we were controlling to have consistent experimental conditions.

Final student assessment was group lab reports in the form of a typical scientific journal article. It was suggested that statistics (e.g., t-test) could easily be accomplished for their experiment and would strengthen their lab reports.

*Implementation*

The day before the students start the lab the *Platymonas* sp. were not growing to a density to be spilt across all the student experiments. Therefore, I went around the building to see if any other research lab had an algal stock available. One lab, that does research on algae, had one marine algae, a strain of diatoms (unknown species). Since brine shrimp are non-selective feeders this diatom culture was used in place of *Platymonas* sp.. However, the included standard curve of the lab protocol would not apply to the student’s experiments, so serial dilutions completed from a highly concentrated sample of the diatoms. The students were instructed to choose a dilution (100, 10-1, 10-2; 10-3 was below detection limits for the spectrophotometer). We used a hemocytometer to count the initial sample then did a series of 1:10 dilutions. Initially, the plan was for students to complete their own cell counts; however, the time constraints prevented this element of the lab. I took the optical density for the initial sample and 3 subsequent 1:10 dilutions. The next class meeting and through e-mail, I provided this new standard curve to the students.

While I was told, by another research lab that regularly hatches brine shrimp, to hatch the shrimp the day before or day that they were needed. This was not sufficient for what the lab and student experiments required; the shrimp were only de-capsulated and not hatched by the time the students started the lab. Therefore, the students used a loop and petri dish to isolate and count eggs introduced into the experiment treatments. This caused some ambiguity in the number of brine shrimp added into their microcosms, because not all eggs hatched. I explained to the students that their counts were representative of hatch success and survival of the shrimp. After examining all the student treatments and surviving shrimp after two weeks, it appeared to be an average of 40% hatch and survival rate. If a group or experimental treatment had better results, it could mean that their treatment was more favorable for the hatching and survival of the shrimp.

All student microcosm jars were stored in an ambient temperature incubator with 24hrs of simulated daylight. Some students made intermediate observations and counted shrimp after a week, all students collected data at 2 weeks, and some continued the experiment an additional week (for a total of 3 weeks). Students measured the optical density in their microcosms after 2 weeks to evaluate the diatom cell density, using the provide standard curve to estimate diatom cells/mL and compared to their starting concentration.

A general observation was that individual microcosms had less shrimp present than expected at each time point. Following the conclusion of the experiments, the contents of all the microcosms were combined into one flask. Some adult brine shrimp still survive in this observation only context (2 months later). The algal population represented by optical density is likely an underestimate, because the cells quickly settled in spectrophotometer cuvettes before the reading was completed.

*Reflections*

Students had to exhibit team work to efficiently set up the experiment. It was possible to complete the setup in an hour; however, the reading of the results went longer with more interested students taking an additional 30min. They had some confusion with the change from *Platymonas* sp. to Diatoms, which can be explained by the students not taking complete notes and only relying on the lab protocol to reference what they did for their experiment setup. There is still some confusion amongst the students about the best way to represent data, especially when other variables that may not have been predicted as an influence on their experiment. Although some students rose to the challenge of including statistics to test if their treatment groups were different at the end of their experiment.

For future implementation, we will incorporate more about brine shrimp and photosynthetic producers before the experiment. We will also do more of an introduction in data collection and representation of independent and dependent variables. It was not expected that they would struggle with utilizing a standard curve and the difference between the dilution and actual cell concentration. It would also be beneficial to have the students read the paper about the project (Hudon & Finnerty, 2013) after they complete their own to give greater context to what a microcosm would be with 3 trophic levels.