Abstract
A hypothesis-driven laboratory is described that introduces students to the complexities of ecosystem function. Students work with live algae, brine shrimp, and sea anemones to test hypotheses regarding the trophic interactions among species, the exchange of nutrients and gases, and the optimal ratio of producers to consumers and predators in enclosed, artificial-seawater ecosystems. In the initial iteration of the activity, multiple ecosystems that differ in their composition of organisms are assembled according to simple recipes by individual students or small lab groups. Two weeks later, the ecosystems are deconstructed, and the students tally the organisms and assess key water-quality measures, including salinity, pH, and ammonia levels. Some sample data and results are presented, as well as tips for successful implementation.

Key Words: Ecosystem laboratory; food webs; metabolic pathways; hypothesis testing; statistical analysis; scientific method; quantitative reasoning.

The resilience of Earth’s ecosystems and the services they provide to humanity (e.g., clean water, fertile soils, food, and other bioproducts) are currently threatened by myriad anthropogenic influences, including pollution, overexploitation of natural resources, and global climate change. A basic understanding of this problem is an essential element of scientific literacy in the 21st century. However, given the complexity of real-world environments, even scientists do not fully understand the factors that influence the stability of ecosystems. Building artificial ecosystems allows students to investigate ecosystem functions in simple, well-controlled experiments (Ruesink et al., 2006; Richardson & Hari, 2009; Oswald & Kwiatkowski, 2011).

Here, we describe an inexpensive and easily modified lab that illustrates fundamental aspects of ecosystem function using sea anemones, brine shrimp, and algae in sealed seawater mesocosms.

Background
This inquiry-based laboratory exercise was designed for first-year non-science undergraduates in a course that fulfills their laboratory and science requirements. In its current form, it could easily be implemented with high school students. Simple modifications that could adapt this activity to middle school students or advanced undergraduate science majors are described below. In our course on “Biodiversity – Causes and Consequences,” the lab is run in the final unit: how the environment affects biodiversity. We hold twelve 2-hour laboratory sessions for groups of 18–20 students over 4 days, but the lab can be tailored to smaller or larger groups. The goal is to have students recognize the biotic factors (e.g., species interactions) and abiotic factors (e.g., salinity) that could affect ecosystem stability in a simple semiclosed system, and to develop a stable system of their own. The successful commercial product, Ecosphere, in which shrimp and microorganisms live for ≥2 years within a glass globe of seawater, is used as an inspirational example for students to create their own long-lived system.

Challenges that affect the stability of a self-contained ecosystem involve balancing gas exchange through photosynthesis and respiration (e.g., Campbell & Reece, 2010, chapters 9–10), balancing the nitrogen cycle (Campbell & Reece, 2010, chapter 35), regulating energy flow in food chains (Campbell & Reece, 2010, chapter 54), and indirect species interactions (Campbell & Reece, 2010, chapter 54). Some of this background material is presented in lecture and some in an accompanying laboratory manual (Finnerty, 2004). Below, we discuss the experimental protocol and some sample results.

Introducing Our Food Chain Cast
Students work with a simple food chain consisting of one or two marine algae species (producers), brine shrimp (grazers), and sea anemones (predators). Our predators, the striped sea anemone, Halilpanella, and the brown sea anemone, Aiptasia (Figure 1A), are members of a very simple and very ancient evolutionary lineage of animals called the Cnidaria. (Other cnidarians include Hydra, corals, and jellyfishes.) Both of these species are hardy in the laboratory.
and available commercially from biological supply companies (e.g., Carolina Biological). These “sit-and-wait” predators attach to the wall of the enclosure and use sweeping movements of their tentacles to capture hapless *Artemia* that swim too close and draw them into the centrally located mouth. Tentacle movements and mouth opening are shown in the accompanying video of *Aiptasia* (supplemental file 1: http://youtu.be/U5WaJDsSCQI). Both anemones can reproduce by sexual or asexual means.

*Artemia salina*, the brine shrimp (Figure 1B), is a crustacean, a relative of crabs and lobsters. They hatch from dessication-resistant cysts, which are harvested and dried commercially and sold to aquarists because the larvae make excellent fish food. The larva, known as a “nauplius,” is an active swimmer that uses its first three pairs of appendages (the first and second antennae and the mandibles) to swim rapidly through the water (supplemental file 2: http://youtu.be/3P-NADts5E). In a few days, the “nauplius” larva develops into the adult shrimp, which is about half an inch long, with prominent eyes and many swimming legs. *Artemia* adults feed by “grazing” on marine algae.

The marine algae are selected from four commercially available species that we have used successfully: *Dunaliella*, *Platymonas* (Figure 1C), *Tetraselmis*, and *Stephanoptera*. All are flagellated green algae that thrive under bright light, with an optimal temperature of 22°C. The algae are active swimmers, as shown in the accompanying videos of *Dunaliella* (supplemental file 3: http://youtu.be/Y8hNaWUMHrg) and *Platymonas* (supplemental file 4: http://youtu.be/BDepco0xQow).

**Materials**
- *Dunaliella* and *Platymonas*, or *Tetraselmis* and *Stephanoptera*, stock cultures
- *Artemia* cysts
- Live anemones (*Haliplanella* or *Aiptasia*)
- 1000-mL bottles, one for each species of algae
- Magnetic stir plates (one for each algal culture)
- Several dozen 100-mL screw-top glass treatment bottles (each group needs seven)
- pH test kits, strips, or meters (in the long run, meters are cheapest)
- Ammonia test kits
- A refractometer to measure salinity
- 10-mL measuring pipets (for measuring seawater)
- A few gallons of artificial seawater (or enough for eight 20-mL treatments per group × the number of groups)
- Microchemistry pipets or sterile transfer pipets for counting *Artemia* and transferring anemones
- Plastic multicavity dishes (for diluting algae)
- Micropipettors and tips capable of pipetting in the 1000-, 100-, and 10-μL ranges
- Microscope with sufficient magnification to visualize and count the algae
- Space for 7 treatments per student group, in lighted conditions, and at normal room temperature (we used a light stand with several shelves)
- 100- to 500-mL vessel (e.g., flask or beaker) for hatching *Artemia* cysts
- Aquarium bubbler for hatching *Artemia* cysts

**Preparation of the Algae Cultures, *Artemia*, & Anemones**

Two weeks in advance of the first lab day, we prepare two cultures of each alga in 1000-mL culture bottles of 100% artificial seawater
(e.g., Instant Ocean) supplemented with Alga-Gro. The algal stocks and nutritional supplement were obtained from Carolina Scientific. We grow the algae on magnetic stir plates under fluorescent lights. Ideally, the cultures will reach about 100,000 algae mL⁻¹, but half that density is sufficient to carry out the lab. Greater algae densities tend to give better *Artemia* survival rates.

The brine shrimp should be hatched a few days before the first lab day, because they do not survive long after hatching unless they are continuously fed. We typically add ~1 g of cysts to ~100 mL of artificial seawater that is aerated continuously using an aquarium bubbler. An inverted plastic drinking bottle with the bottom cut off, supported in a ring stand, makes an ideal culture vessel (especially if the cap can be easily opened to decant the hatched shrimp).

We typically timed our order of anemones (usually *Aiptasia*) from Carolina Scientific to arrive a week before the start of the lab so that they could adjust to a new artificial seawater environment that we also aerated with an aquarium bubbler.

☐ Assembly of the Ecosystems

We run this lab exercise over the course of two 2-hour lab sessions. At the first lab session, students assemble their ecosystems in glass screw-top bottles, combining 20 mL of artificial seawater, 2 mL of algal culture, and the specified numbers of brine shrimp and sea anemones for each treatment. For the purpose of assembling the ecosystems, each lab section of 18–20 students is divided into four or five groups of four or five students – this allows for sufficient experimental replication while distributing the more time-consuming tasks among a larger group of students. Group sizes should be smaller if the total number of students is small. Aim for at least 10 groups in total per lab day to get reasonable statistics.

Tasks for each group involve labeling the treatment bottles, adding seawater, determining the density of algae in the cultures, and adding shrimp and anemones. Small plastic pipets can be used to capture a few *Artemia* so that they can be dispensed one at a time into each treatment according to Table 1. The *Artemia* are small, and students may need to practice counting them out on a Petri dish. Students aim for particular numbers of *Artemia* in each treatment, as shown in Tables 1 and 2, but record the actual number of *Artemia* added so that the percent-change calculation will be accurate.

The most time-consuming step in the preparation of the ecosystems is determining the concentration of the algae. Students will calculate the percent change in the algae populations in each treatment after a 2-week incubation, so reliable estimates of the initial

### Table 1. Students enter their initial quantities of algae/mL and *Artemia* in this table in session 1 and the final values along with abiotic measurements in session 2 (2 weeks later).

<table>
<thead>
<tr>
<th>Treatment 1</th>
<th>Treatment 2</th>
<th>Treatment 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Starting Conditions</strong> (# of each species)</td>
<td><strong>Incubation Time</strong></td>
<td><strong>Incubation Time</strong></td>
</tr>
<tr>
<td>2 mL algae (<em>Platymonas</em>)</td>
<td>14 days</td>
<td>14 days</td>
</tr>
<tr>
<td># algae/mL:</td>
<td># Artemia ___ (2)</td>
<td># Artemia ___ (4)</td>
</tr>
<tr>
<td># Artemia ___ (8)</td>
<td># Artemia ___ (4)</td>
<td># Artemia ___ (8)</td>
</tr>
<tr>
<td><strong>Final Conditions</strong></td>
<td><strong>Percentage Change</strong></td>
<td><strong>Percentage Change</strong></td>
</tr>
<tr>
<td># <em>Platymonas</em> _______</td>
<td># <em>Platymonas</em> _______</td>
<td># <em>Platymonas</em> _______</td>
</tr>
<tr>
<td># <em>Artemia</em> _______</td>
<td># <em>Artemia</em> _______</td>
<td># <em>Artemia</em> _______</td>
</tr>
<tr>
<td># <em>Platymonas</em> _______</td>
<td># <em>Platymonas</em> _______</td>
<td># <em>Platymonas</em> _______</td>
</tr>
<tr>
<td># <em>Artemia</em> _______</td>
<td># <em>Artemia</em> _______</td>
<td># <em>Artemia</em> _______</td>
</tr>
<tr>
<td><strong>Seawater:</strong></td>
<td><strong>Seawater:</strong></td>
<td><strong>Seawater:</strong></td>
</tr>
<tr>
<td>NH₃/NH₄⁺</td>
<td>NH₃/NH₄⁺</td>
<td>NH₃/NH₄⁺</td>
</tr>
<tr>
<td>ppm:</td>
<td>ppm:</td>
<td>ppm:</td>
</tr>
<tr>
<td>Salinity:</td>
<td>Salinity:</td>
<td>Salinity:</td>
</tr>
<tr>
<td>ppt</td>
<td>ppt</td>
<td>ppt</td>
</tr>
<tr>
<td>pH:</td>
<td>pH:</td>
<td>pH:</td>
</tr>
</tbody>
</table>

### Table 2. The initial conditions of all 13 treatments. Half the students assemble treatments 1–7, and the other half assemble treatments 8–13.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume of alga A (either <em>Platymonas</em> or <em>Stephanoplera</em>; mL)</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Volume of alga B (either <em>Dunaliella</em> or <em>Tetraselmis</em>; mL)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Number of brine shrimp</td>
<td>2</td>
<td>4</td>
<td>8</td>
<td>16</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>4</td>
<td>8</td>
<td>8</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Number of anemones</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
populations are necessary. This is set up as a class problem at the beginning of the lab: how is it possible to quickly and reliably estimate the number of algae in a milliliter of a concentrated culture whose density may exceed 100,000 mL\(^{-1}\). To observe the thriving and abundant algae and recognize the difficulty of counting them as they rapidly swim through the medium, students should visualize a small aliquot of algae solution under a microscope (a 10-μL aliquot is useful because it should fit within the microscope’s field of view at 40x magnification). Reliably, some students hit on the idea of dilution: dilute the algae to the point where a small aliquot may be accurately counted, and multiply the count by the dilution factor to determine the original density. For the dilutions, students are cautioned to make sure that the algae solution is well mixed, because drawing from the bottom or off the top of an unmixed culture could bias the counts up or down, respectively. Slide covers are not used because they may stop the algae from swimming, which would make them more difficult to count.

Algae counts can vary widely from one group to the next, so we designate sub-teams of algae counters who make 8–10 estimates of algal density and average those to provide a single estimate for the entire class. This official algal count is recorded by the instructor.

Once the algae have been counted satisfactorily, students add 2 mL to each treatment, which already contains the other organisms. The treatments are then sealed under airtight lids and placed under lights to incubate at room temperature for 2 weeks. Assembly of the ecosystem treatments typically takes 1.5 hours maximum, with an additional half hour spent on instruction for using the pipets and counting algae. An assembled ecosystem from the course is shown in Figure 2.

○ Testing Hypotheses

Hypothesis 1: There is an optimal ratio between the population of primary producers (algae) and the population of grazers (brine shrimp) at which the ecosystem will exhibit the greatest stability. Students test this by holding the density of algae constant and varying the number of brine shrimp (from 2 to 16) in treatments 1 to 4.

Hypothesis 2: Differences in the composition of the community of primary producers will lead to differences in the stability of the ecosystem. Students test this by holding the density of brine shrimp constant and varying the species of algae in treatments 5 to 7.

Hypothesis 3: The presence of the predator (sea anemone) will decrease the abundance of grazers and increase the abundance of producers (in relation to an ecosystem without predators). This may destabilize the ecosystem if the grazer becomes extinct, but it may also stabilize the ecosystem if the grazer does not become extinct and is prevented from causing the extinction of the algae. Students test this by comparing pairs of otherwise equivalent ecosystems, with or without predators, in treatments 8 to 13. In practice, we have had different groups of students test hypothesis 3 than those who tested hypotheses 1 and 2.

○ Deconstruction of the Ecosystems

After the 2-week incubation period, students assess the health of each of their ecosystem treatments (either 1–7 or 8–13). If all the Artemia and anemones are dead, the ecosystem has crashed, and students are challenged to determine why. Students also need to determine whether and why some ecosystem treatments are more stable than others. Ecosystem stability will have been influenced by three kinds of interactions: direct organismal interactions (e.g., shrimp eat all the algae), indirect organismal interactions (e.g., anemones eat shrimp, reducing shrimp predation on algae), and indirect biochemical interactions (e.g., photosynthesis by algae produce oxygen that is used by shrimp during oxidative respiration).

The specific tasks are to count the number of living algae, brine shrimp, and anemones, and to measure pH, ammonia, and salinity. Again, the most time-consuming step is counting the algae, and this task is even more involved because now the number of surviving algae in each treatment must be counted, not just the density of a common algae stock culture. We recommend that two students from each group take on the algae counting, and the other group members divide up the remaining tasks. In addition to counting the organisms, students measure pH using a digital meter, salinity using a refractometer, and NH\(_3\)/NH\(_4\)\(^+\) concentration using aquarium test kits. Data gathered by all the lab groups that meet on a single day (usually 8–12 groups) are collected by the instructor for inclusion on a single spreadsheet, which is then distributed to the students at the end of the day. Each student is then in possession of data on initial and final organismal censuses for 8–12 replicates of each treatment.

In their reports, students are asked to summarize the results of their treatments – in particular, to assess how the initial species composition and abundance affected the population levels of algae and brine shrimp. In challenging the students to conclude whether two treatments produce different results, we explain the concept of
variance. Students quantify changes in the organismal composition within each treatment as the average percent change in the abundance of each species, plus or minus the standard error. A template is shown in Table 3. We define the standard error as the standard deviation divided by the square root of the number of observations and use it as the error in the mean (Taylor, 1982). If the means (± standard error) overlap, the students are instructed to conclude that there is no significant difference between the treatments. For a more advanced statistical treatment, the students could be required to perform an analysis of variance (ANOVA) and report the P values. They are also asked to assess whether and how species composition and abundance affected the salinity, pH, and ammonia levels.

○ Sample Results

In Figure 3, we present data from two different years of the experiment. In general, the error bars represent a small fraction of the means (e.g., typically ≤10%). This consistency from replicate to replicate indicates that the initial conditions have a fairly predictable and consistent effect on the final results. Notice that in both years, the number of brine shrimp at the outset of the experiment displays a strong positive correlation with the magnitude of the population decrease in brine shrimp.

However, the outcome of this lab exercise is not preordained. In year A, the number of shrimp does not appear to affect the algae populations. Whether there are 2, 4, 8, or 16 shrimp in the treatment, nearly all the algae died. In that year, students would have been expected to posit plausible explanations for the death of algae in all treatments, regardless of shrimp abundance (e.g., a problem with the lighting, an algal pathogen, etc.). By contrast, in year B, the abundance of shrimp appeared to affect the abundance of algae (i.e., the greater the number of shrimp at the outset of the experiment, the greater the abundance of algae at the close of the experiment). This is counterintuitive, given that the direct effect of the shrimp on the algae is to reduce their abundance. However, astute students will notice that in treatments with four or more shrimp, there was a near 100% extinction of the shrimp (so there were fewer shrimp by the end of the incubation period, meaning less grazing activity, and the decay of dead shrimp may have fertilized the algae). In treatment 1, the high survival of shrimp seems to have led to a large decrease in the algae, and this is reversed in treatment 4, in which a large decrease in shrimp led to greater survival of algae in that treatment compared with other treatments.

It is worth noting that students have difficulty distinguishing the two species of algae in the same treatments. We aim to rectify this by printing large images of each species of algae and highlighting differences that students might identify under higher magnification than they tend to use for counting the algae.

We have obtained some of our clearest results overall in testing the third hypothesis, which examines the effect of a predator. As seen in Figure 4, the even-numbered treatments, which did not have an anemone, each had relatively lower percent decreases in Artemia and, consequently, much higher decreases in algae than the odd-numbered treatments in which an anemone was present (compare treatments 8 vs. 9, 10 vs. 11, and 12 vs. 13). In fact, the

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Observations (% change observed by each group)</th>
<th>Mean</th>
<th>Variance</th>
<th>Standard Deviation</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment 1</td>
<td>-50.0, 0.0, 0.0, 0.0, 0.0, 50.0, 50.0, 50.0, 50.0, 100.0, 100.0</td>
<td>36.4</td>
<td>45.2</td>
<td>20.45.4</td>
<td>13.6</td>
</tr>
<tr>
<td>Treatment 2</td>
<td>25.0, 50.0, 50.0, 50.0, 50.0, 50.0, 50.0, 50.0, 75.0, 75.0, 100.0</td>
<td>63.6</td>
<td>20.5</td>
<td>420.4</td>
<td>6.2</td>
</tr>
<tr>
<td>Treatment 3</td>
<td>62.5, 62.5, 62.5, 75, 87.5, 87.5, 100.0, 100.0, 100.0, 100.0</td>
<td>85.2</td>
<td>16.6</td>
<td>275.6</td>
<td>5.0</td>
</tr>
</tbody>
</table>

Figure 3. Sample percent decreases for treatments 1 to 4 for Artemia and one species of algae for two separate runs of the experiment, in years A and B.
even-numbered treatments were found to be on the verge of complete collapse because the *Artemia* had grazed the algae down to almost nothing. These results represent an experimental validation of the trophic cascade concept, whereby the abundance of a secondary or tertiary consumer decreases the abundance of those organisms one level lower in the food chain while increasing the abundance of those organisms two levels lower.

**Discussing the Limitations of Microcosms**

Microcosms have been widely used in ecological research to test hypotheses about the factors that influence the diversity and abundance of organisms in natural communities. For example, in this exercise, students test whether the presence of a secondary consumer affects the abundance of the primary producer. Students can gain critical insights into the scientific method and the practice of ecological research if they are challenged to consider the strengths and weaknesses of constructing artificial microcosms versus directly observing or manipulating natural communities. These two approaches can be compared on the basis of their tractability, generality, and realism (Table 4; Srivastava et al., 2004).

**Altering the Lab for More or Less Advanced Students**

This lab can easily be modified to accommodate advanced undergraduates or graduate students by incorporating greater experimental or computational complexity. The experimental complexity could be increased by investigating more of the relevant variables that

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**Figure 4.** Sample data for percent changes in algae and *Artemia* in treatments with no anemone (even-numbered, solid) and with an anemone (odd-numbered, striped).

**Table 4.** Comparison of constructing artificial microcosms versus directly observing or manipulating natural communities, based on their tractability, generality, and realism.

<table>
<thead>
<tr>
<th>QUESTION: How does the presence of secondary consumers affect the abundance of primary producers?</th>
<th>TRACTABILITY (Is it easy to control and manipulate the system and replicate the experiment?)</th>
<th>GENERALITY (Will the findings have broad application to other systems?)</th>
<th>REALISM (Do the dynamics of the system reflect what happens in nature?)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>APPROACH:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laboratory Constructed Artificial Microcosms. Assemble different collections of species in experimental enclosures. Add secondary consumers to some microcosms but not others. Monitor changes in the abundance and diversity or primary consumers.</td>
<td>HIGH. The species composition is almost entirely under the control of the investigator, and the exact starting conditions can be replicated any number of times.</td>
<td>UNCERTAIN. Because the species composition is contrived, there is no certainty that the findings will be generalizable to other natural or artificial communities.</td>
<td>LOW. Artificially constructed microcosms generally capture only a small fraction of the complexity of natural communities.</td>
</tr>
<tr>
<td>Observations of (or Experimental Manipulation of) Natural Communities. Identify natural communities that differ in their species composition, or manipulate natural communities so that they come to differ in their species composition (e.g., identify or create plots in which secondary consumers are present/abundant and others in which secondary consumers are absent/rare). Monitor changes in the abundance and diversity or primary consumers.</td>
<td>LOW. The large size of natural communities makes it difficult to manipulate the species composition. Natural variation among communities over time and space makes it impossible to precisely replicate a given experiment.</td>
<td>UNCERTAIN. Because there is variation among natural communities, it is not a foregone conclusion that the results will be generalizable to other natural communities that may differ with respect to their species composition or other environmental variables.</td>
<td>HIGH. By definition, natural communities are realistic.</td>
</tr>
</tbody>
</table>
affect ecosystem stability, such as the physical properties of the environment (e.g., light levels, light quality, or temperature), pollutants (e.g., common household items, herbicides, pesticides, or fertilizers), habitat complexity (e.g., presence and type of sediment or presence of vertical structures), or even microbial diversity of the ecosystems (monitored via classic microbiological approaches or even metagenomics). The computational complexity could be increased by introducing ANOVA and significance testing, incorporating regression analysis, or comparing different metrics of biodiversity (e.g., species richness and Simpson's index).

Likewise, the lab could be rendered more digestible for middle school students by eliminating the most technically challenging manipulations (e.g., have the teacher demonstrate the quantification of algae), simplifying the statistical analysis, and discussing the more subtle and complex interpretations of the results rather than challenging the students to derive these explanations on their own.

Conclusions

This 2-week lab gives students experience in working with a phylogenetically diverse collection of living organisms, standard biological measuring equipment, statistical analysis, and hypothesis testing. They also explore how simple ecosystems work both in terms of species interactions and the cycling of key biochemicals. In our experience, students enjoy working with live creatures and, in particular, many of them develop an affinity for the brine shrimp, particularly as they grow in size, develop prominent eyes, and even give birth to offspring (after a few weeks of incubation in the competition phase of the lab). Admittedly, our compressed schedule leaves students a little rushed to analyze their data and assemble a new challenge ecosystem in the lab’s second week. However, most students find this a valuable exercise and enjoy the competition aspect of the lab. With more background prepping in lecture, we are confident that students can gain even more from this lab exercise.

References


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