

# Lab II-2

## Observing Succession in Aquarium Microcosms

### Equipment and Materials

You'll need the following items to complete this lab session. (The standard kit for this book, available from [www.thehomescientist.com](http://www.thehomescientist.com), includes the items listed in the first group.)

#### Materials from Kit

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| <input type="checkbox"/> Goggles         | <input type="checkbox"/> Slides, flat          |
| <input type="checkbox"/> Coverslips      | <input type="checkbox"/> Stain: eosin Y        |
| <input type="checkbox"/> Methylcellulose | <input type="checkbox"/> Stain: methylene blue |
| <input type="checkbox"/> pH test paper   | <input type="checkbox"/> Thermometer           |
| <input type="checkbox"/> Pipettes        |  |

#### Materials You Provide

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|---|---|
| <input type="checkbox"/> Gloves                                   | <input type="checkbox"/> Pond life reference material(s) (see text) |
| <input type="checkbox"/> Aquarium microcosms (from preceding lab) | <input type="checkbox"/> Watch or clock with second hand            |
| <input type="checkbox"/> Particulate masks, N100 (see text)       |   |

### Background

**Succession**, a fundamental concept in ecology, is the process by which a community progressively transforms itself from an arbitrary starting point to the steady-state equilibrium of a stable community. The point at which that equilibrium is reached depends on environmental parameters and the types of organisms present at the starting point, although not necessarily their initial numbers.

Our aquarium microcosms represent arbitrary communities. We hope that those communities are very similar, but we cannot know that they are identical. For example, one of the microcosms might contain a few examples of a rare organism, while another contains none of that organism. If that organism is, say, a predator upon another species that is present in both microcosms, the succession we observe in the two microcosms will be very different. In the first microcosm, stable populations of the predator and prey organisms will likely develop, while in the second microcosm the absence of the predator may result in uncontrolled growth of the prey organism. Or a third organism may step in to assume the ecological role of predator.

In short, microcosms like ours are somewhat predictable in terms of succession, but even very small changes in the community makeup may cause dramatic changes in succession. In the extreme case, one microcosm may flourish over a period of weeks to months (if not indefinitely), while another, apparently identical, microcosm may quickly approach senescence and die off. That's one of the reasons we suggest building several of these microcosms. The other reason is that in the next lab session we'll intentionally alter the environmental characteristics of some microcosms and compare their succession to those of a control microcosm.

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In terms of subject matter, these microcosm lab sessions actually belong with the ecology group. However, because we'll be observing the microcosms regularly over a period of several weeks to several months, we needed to get the microcosms started early, so we elected to place these lab sessions in their own group early in the book.

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In this lab session we'll observe and catalog some of the microscopic life present in our aquarium microcosms.

## Procedure II-2-1: Observe succession in microcosms

With regard to microcosms, succession is just another word for changes, and much of the educational value in microcosms comes from observing and documenting those changes on a regular (and frequent) schedule. Changes can be observed on many levels, from simple observations of gross changes such as the color and turbidity of the water to detailed observations of the types, numbers, and other characteristics of the various microorganisms present in the microcosm and how they change over time.

Obviously, detailed observations require more time than casual observations. Doing detailed observations and counts requires a significant commitment of time and effort, particularly if you have several microcosms. If time is limited, simply do the best you can, keeping in mind that changes are likely to occur more rapidly at first and more slowly later in the life cycle of the microcosms.

Ideally, you should perform this procedure initially on the day you create the microcosms, repeat this procedure for each of your aquarium microcosms every day for the first week, then every two to three days once the microcosms begin to stabilize, and then once a week after full equilibrium has been reached (which may occur at different times for different microcosms).

1. Put on your gloves and goggles.
2. Observe the color and degree of turbidity of the microcosm and record your observations in your lab notebook.

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If you have a digital camera available, shoot an image of the microcosm. Because we're concerned about changes from one observation to the next, try to ensure that you shoot images consistently each time, using the same background, level and direction of light, and so on. Shoot with natural lighting. If you can disable the flash, do so. Otherwise, hold a finger over the flash while shooting the image to prevent reflections from the flash from obscuring details of the microcosm.

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3. Carefully remove the lid from the microcosm, disturbing the contents as little as possible. (It's not uncommon for microcosms to stink to high heaven—particularly after they have incubated for several days or longer—so make sure you have adequate ventilation.)

Remember that you don't know exactly what's growing in those microcosms. It's probably not the Andromeda Strain, but there might be a real nasty growing in there, maybe even several nasties.

Use full aseptic precautions each time you open a microcosm. Wear gloves, goggles, and (if you really want to be fully protected) an N100 particle mask. Wash the gloves in soap and water before removing and discarding them, and then wash your hands thoroughly in soap and water. When you remove specimens, sterilize them before discarding them. Always replace the lid of the microcosm immediately when you're not actually obtaining samples from it.

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4. Measure the temperature of the water, and record it in your lab notebook. (Do not stir the microcosm; simply dip the thermometer into the water and withdraw it once it registers the temperature.)
5. Use the tip of the thermometer to transfer one drop of the microcosm water to a piece of pH test paper. Record the pH value in your lab notebook.
6. Use a clean pipette to withdraw a drop of water from the surface of the microcosm. Transfer it to a flat slide, add a drop of methycellulose to slow down the fast-movers, and put a coverslip in place.
7. Observe the slide at low magnification (40X), and note as many different organisms as possible. Even at low magnification, depending on the state of the microcosm, it's not unusual to observe a dozen or more discrete species, nor is it unusual to see only a few. Scan the full area under the coverslip to make sure you don't miss any species.
8. Using a pond-life reference manual or Internet resources, attempt to identify each species present, or at least the genus.

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Quite often, you'll be able to identify the genus but not the particular species. For example, if an amoeba is present and you are certain it is *Amoeba proteus*, record its presence in your lab notebook by genus and species. On the other hand, if there's an amoeba present but you are uncertain as to its species, record it as simply *Amoeba* sp., or if several clearly different amoebae are present, identify the multiple species as *Amoeba* spp. and assign your own numeric or alpha identifier to each.

For each species you see, particularly those you can't identify, make a reference sketch (or shoot an image, if you have that capability) and note the particulars for the species, including coloration (if any), shape, approximate size (and range if different individuals are different sizes), whether or not the species is motile (and, if so, how fast), and any unusual features. For example, you might describe a euglena as "shape alternating between circular and worm-like with whip tail, length ~30  $\mu\text{m}$  (about five times width), granular texture with greenish mottling and one small red spot. Moves at moderate speed."

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9. Scan the entire populated area of the slide and record your impressions of the relative numbers of each species present as "very abundant", "abundant", "moderate", "rare", or "very rare".
10. Center a populated area of the slide under the objective and perform an actual count of each species visible in the field of view, beginning with those species that move slowly or not at all. For motile species, do a 15-second count of each species. If an individual swims into the field of view during the 15-second period, increment your count by one; if an individual swims out of the field of view, decrement your count by one. After you complete the count, center another

random populated area under the objective and repeat the count. Do that again, for a total of three counts, and average the number of individuals in each species for the total sample.

11. Repeat your observations at medium (100X) and high-dry (400X) magnification, noting and recording any species that become visible at higher magnification.

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At 400X in particular, a wide variety of bacterial species may be visible. You needn't attempt to determine their species nor even genera, but do note their form (coccus, rod, spiral), anything otherwise special about their appearance, and their relative abundance.

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12. To document the original status of the microcosm, label and date a clean microscope slide, transfer another drop of water from the surface of the microcosm to the slide, and spread the drop across the central area of the slide. Flame the slide to kill the microorganisms present and affix them to the slide. Stain the slide with methylene blue and then with eosin Y. Dry the slide and observe it to ensure that all species you noted are present on the slide.

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You needn't use a coverslip for this reference slide unless you want to make a permanent mount.

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13. Using clean pipettes, repeat the preceding steps using specimens from near the vegetation and from near the bottom sediment. You will probably find that the relative abundance of species changes significantly. Some species may be present in abundance or entirely absent in different areas of the microcosm.

If you have time, repeat this procedure for each of your other aquarium microcosms to establish baseline population estimates for each of them. Don't make the mistake of focusing on plentiful species and ignoring organisms that are not present in large numbers. Relative population counts will probably change over time, and those changes may (or may not) be dramatic.

Schedule follow-up observations now. If possible, observe them daily for the first week, ideally at the same time of day each time. Follow-up observations needn't be as detailed or time-consuming as this first observation. Just do quick population estimates for as many species as possible, looking for obvious changes and trends. For example, a species that was initially present in small numbers may increase its numbers significantly over the first few days, while the population of another that was plentiful initially may decrease noticeably.

If time is limited, focus your attention on only one of your microcosms, which you can designate as your control microcosm. You should be able to do a follow-up observation on the surface, vegetation, and sediment of your control microcosm in perhaps 15 minutes. If you have more time and particularly if the initial state of one or more of your other microcosms differed noticeably from your control microcosm, it's useful to do follow-up observations on it or them as well.

As time passes, you can change the frequency of your follow-up observations depending on what changes you see occurring, and how quickly. During the first few days, changes are likely to occur quickly. After a week, you can probably reduce the frequency of follow-up observations to once every two or three days without missing much. As the microcosms begin to settle down and near equilibrium, you'll probably find that few changes occur from one week to the next.

Do not be surprised if one or more of your microcosms dies off. That's why we made spares.

## Review Questions

[??? Production: Please strip the answers \(formatted as comments\) from the final layout. RBT](#)

1. What gross changes did you observe in your microcosms as they aged?

Answers will vary, but in a typical microcosm, both turbidity and pH will increase as the microcosm ages. The odor of the microcosm also typically increases dramatically over the first week or two.

2. Did you notice any change in the relative sizes of particular types of organisms as the microcosm aged?

Answers will vary, but in a typical microcosm many of the organisms will show no noticeable change in average size. Some organisms whose population was originally a relatively large number of relatively small average size will show a change to a relatively smaller number of relatively larger individual organisms.

3. As your microcosm progresses toward equilibrium, what changes did you observe in terms of the types of organisms present and their relative populations?

Answers will vary. In a typical microcosm, initially a few species are generally present in relatively large numbers, with many other species present in much smaller numbers. As the microcosm approaches equilibrium, the relative populations of the various species become more similar, with many species present in high numbers. (There will still be some species that are rare or extremely common, but overall the microcosm typically becomes much less lopsided.) In many cases, you may discover “new” species as the microcosm matures. Those species were present in very, very small numbers initially, so small that you did not happen to obtain one of them in any of your initial specimens.

4. In terms of the species mix, did you notice any significant changes as the microcosm matured?

Answers will vary, but in a typical microcosm heterotrophs—also called “consumers” or “predators”—such as protozoa are present initially in relatively smaller numbers, while autotrophs—also called “producers” or “prey”—such as algae and cyanobacteria are present initially in relatively much larger numbers. As the microcosm approaches equilibrium, the relative population counts of heterotrophs tend to increase while those of autotrophs tend to decline until a balance is reached.

5. Why is it important to observe aseptic procedures when working with water from a microcosm?

Answers will vary in detail, but the major concern is the possible presence of viruses, bacteria, and/or protozoa that are human pathogens.

6. What safety procedures should you use when working with microcosms?

Answers will vary in detail, but the following are important:

Keep the microcosms sealed except when you are actually obtaining specimens

Wear goggles, gloves, and a particulate mask whenever there is a risk of contact

Sterilize all equipment using flame, heat, or chlorine bleach after using it

Sterilize all specimens before discarding them

After you finish work, wash your gloves with soap and water before removing them, and then wash your hands with soap and water