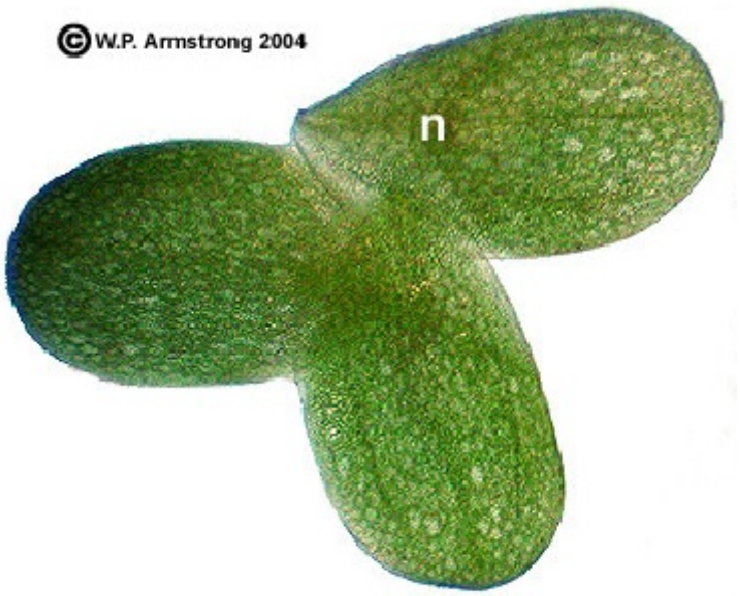
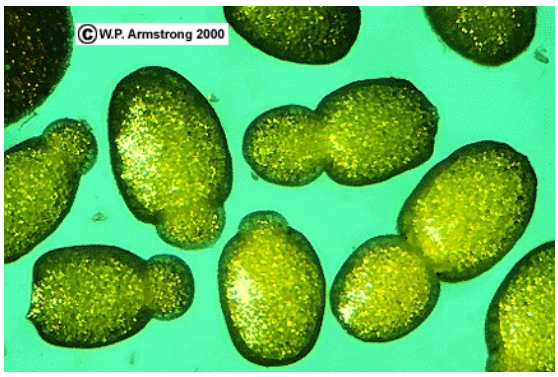
Population Growth and Competition

Background (see Brower, Zar & von Ende, chapters 4a & 4c). – Observations in nature indicate that sometimes populations appear to stay close to a steady level even though there is some variation (e.g., the number of pigeons in Gambier). Other populations appear to "explode" (e.g, ladybird beetles) or "crash" (e.g., large-flowered trillium in local woods). Many hypotheses exist to explain mechanisms for such patterns. What are some of those hypotheses?

Based on class discussion, we should see that alternative hypotheses fall into the general categories of "sampling effects," "intrinsic factors," and "species interactions." Finding the best hypothesis for a particular system requires careful measurement and experimental manipulation.

Natural History
Ponds and lakes can be colonized by small, floating plants (angiosperms) such as *Lemna minor* and *Wolffia borealis*. Unlike most Angiosperms, floating aquatic plants reproduce asexually almost exclusively. Another way to say this is that all their resources are allocated to vegetative growth. New individuals are produced by buds forming along the side of fronds. A final point about the life cycle of these plants is that each individual plant has a limited life span (about two weeks for *Wolffia* and a month for *Lemna*).



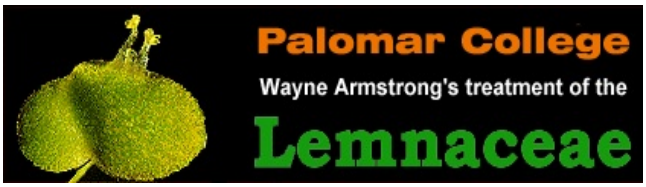


Lemna ***Wolffia***

Lemna extends short roots to absorb nutrients dissolved in the water column, while *Wolffia* lacks roots and absorbs nutrients through its leaves. Although dissolved nutrients may be limited, these plants have an advantage over submerged plants in obtaining light because they float on the surface. As a tradeoff, these species tend to be small (so that they float on the surface tension of the water). Small size provides some advantage in dispersal and colonization as well, because plants can become stuck on birds' feet and feathers (ducks and herons) and be carried among different bodies of water.

Another disadvantage of this ecological niche is that icing of water in the winter kills most of the individuals. In contrast, submerged aquatic plants are more protected from freezing by the high heat capacity of water. A consequence is that floating aquatic plants frequently are in the modes of population expansion. Does this mean that intrinsic factors are much more important than competition in limiting density? This is a question that can be approached experimentally.

Background on the Lemnaceae



Place a few individual plants in a small petri dish and examine them with a hand lens. Practice counting the number of fronds or individuals. Note that Lemna *reproduces asexually by buds formed on the side of the parent frond. Think about the best way to quantify population size for this kind of plant.*

Designing the Experiment

The class will collaborate to design an experiment to compare the effects of intrinsic (single-species) and competitive effects on the growth of floating, aquatic plants. To provide a starting point, the technique for starting a culture of aquatic plants includes the following steps:

- Add artificial pond water to a 2.5cm diameter, labeled test tube, to a mark 2 cm from the top of the tube.
- Place a starting sample of *Lemna* or *Wolffia* in the tube.
- Cover the tube with clear plastic wrap, then poke a few small holes in the plastic wrap.
- Place tube in a rack, and then move the rack to a growth chamber (f18:6 L:D, 24 C).
- With each count of the system, swirl the water in the test tube (but be sure plants are not left on the side of the test tube).

In designing your experiment, you should first be clear about what hypotheses you are testing. Write them in your laboratory notebook to be explicit:

Following are issues that your experimental design must consider. Work in pairs to develop a proposal. We will establish a protocol for the whole class based on the best ideas.

Initial Conditions
Treatments
Replicates
Layout of plots

What should be measured?

How often should the system be measured?

How will the data be analyzed?

How should the data be recorded? **(Set up a data sheet)**

Suggestions for organizing a data-collection form

General principles to consider

- What information is required?
- How will the data be organized for analysis?
- What will reduce the chance that you will forget to include required data?

For the *Lemna*-*Wolffia* experiment, you should think of each observation on a culture tube to be a single "record." Each record will have the following attributes:

- Calendar date of the count
- Day of experiment (0 = start, to end)
- The treatment category for the culture
- The research group making the observation
- The number of *Lemna*
- The number of *Wolffia*

Data eventually must be transferred to a spreadsheet format (either in Excel or Minitab), so column organization is simplest. For example, you could make up data sheets that look like the following:

date	expt day	treatment (W/L/WL)	group	*Lemna* # or *	*Wolffia* # or *

What is in "artificial pond water"?
1.3 mM NaCl, 0.8 mM $CaCl_2$, 0.1 mM Kcl, 0.2 mM $NaHCO_3$

Supplemental reference:
Lemon, G. D., U. Posluszny, and B. C. Husband. 2001. Potential and realized rates of vegetative reproduction in *Spirodela polyrhiza*, *Lemna minor*, and *Wolffia borealis*. Aquatic Botany 70:79-87.