A Population Study

Introduction

What affects the size of a population? How fast can a population grow? What limits the growth? Duckweed is an excellent organism for studying some of these questions.

Concepts

- Population growth rate
- Limiting factors

Background

Duckweed is widely distributed and found on the surface of bodies of quiet fresh water—ponds, swamps and slow-moving streams. Duckweed is eaten by ducks, geese, fish and some snails. In cold regions, clusters of fronds sink to the bottom of the body of water in the fall. In the spring, the plants float to the surface and begin reproducing. Duckweed grows best in well-lighted areas but not direct sunlight and can reproduce rapidly when conditions are ideal.

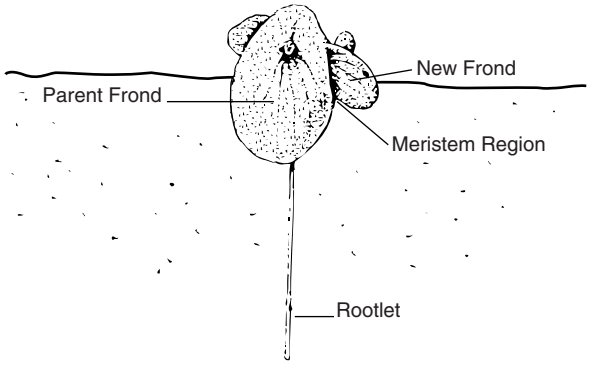

Figure 1. Typical Duckweed Cluster

The oval or elongated, flattened bodies of duckweed are made up of leaf-like stems called *fronds*. The fronds float on the water's surface while thread-like rootlets trail in the water. See Figure 1. Even though duckweeds are among the smallest flowering plants, reproduction by flowering is rare in indoor conditions. Reproduction is usually by vegetative means. New fronds arise from growth regions—*meristems*—located in one or two pockets near the sides at one end of the parent frond. As new fronds grow, they may remain attached to the parent frond for a short time before separating. This growth pattern makes duckweed look like it is growing in clusters. Depending upon the nature of the body of water and its motion, duckweed can form large mats covering the entire surface of the body of water.

Duckweed undergoes two types of population growth—exponential and linear. During an exponential growth phase duckweed may grow an additional 0.3 g of plant tissue for every 1 g of existing tissue. As long as nutrient and light conditions are met, the limiting factor for duckweed growth is the number of fronds available to grow. During a linear growth phase the limiting growth factor is a lack of proper light or a lack of one or more nutrients.

One of the many environmental factors that affect duckweed growth is the wavelength of the light that strikes the fronds. Different wavelengths of visible light appear as different colors. We will study how wavelength affects the duckweed's growth over several weeks.

Materials

Duckweed fronds, 16
Fertilizer, liquid
Potting soil
Water, distilled or spring water
Cellophane, red, green or blue
Dissecting needle or forceps
Graduated cylinder, 25-mL
Marker or wax pencil
Petri dishes, 60 × 15 mm, 2

Safety Precautions

The materials used in this laboratory exercise are considered relatively nonhazardous. However, chemical splash goggles and chemical-resistant gloves should be worn. Wash hands thoroughly with soap and water before leaving the laboratory. Follow normal laboratory procedures. Please review current Material Safety Data Sheets for additional safety, handling, and disposal information.

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Procedure

Part A. Duckweed Population Growth

1. Use a marker to label two Petri dishes with your name, date, and 1 or 2, respectively.
2. Place 15 mL of distilled water or spring water into each Petri dish.
3. Add one drop of fertilizer and a pinch of potting soil to each Petri dish. Swirl the solution in the Petri dish.
4. Let both Petri dishes sit undisturbed for several minutes to be sure the soil and fertilizer mix into the water.
5. Use a dissecting needle or forceps to carefully transfer three separate duckweed plants to the surface of the water in each Petri dish.
6. Count the number of total fronds in each Petri dish. Record the number of fronds in each Petri dish in a data table.
7. Place the tops on the Petri dishes.
8. Carefully wrap one Petri dish in a single layer of colored cellophane.
9. Place both Petri dishes in a well-lighted area but not in direct sunlight.
10. During the remainder of the experiment, replace any lost water volume with distilled or spring water.
11. Count the number of fronds present each week for the next six weeks. Try to count the number of fronds on the same day of each week.
12. Record data each week in the data chart. Graph your results.

Part B. Change in Duckweed Population Growth

1. How might the growth rate of duckweed be increased? What might be done to get a "bumper crop" in a hurry? Form a research group as directed by your teacher. Brainstorm hypotheses and discuss variables to be tested. Review the list of possibilities. Discuss possible experiments that might test each hypothesis. Be sure to discuss any controls.
2. Pick the hypothesis that seems to be most viable and interesting to your group. Design an experiment to test the hypothesis. Write up the experimental design in detail and discuss it with the teacher.
3. Secure the required materials from the teacher.
4. Conduct the experiment. Create appropriate data tables and record the results from the experimental work.
5. Write a complete laboratory report for the experiment. Be sure to include the following:
   a. State the hypothesis.
   b. Describe the experimental design including any controls.
   c. Document the results of the experiment.
   d. Write an interpretation of the experimental results.
   e. Is the hypothesis accepted or rejected?
   f. What further experiments are suggested by the results?
6. Conduct a class seminar and share all of the experimental designs and results.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory waste. Materials used in this activity may be disposed of according to Flinn Suggested Disposal Method #26a. Duckweed should be destroyed using Flinn Biological Waste Disposal Type I, autoclave or chemical sterilization prior to disposal.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12
Constancy, change, and measurement
Content Standards: Grades 5–8
Content Standard A: Science as Inquiry
Content Standard C: Life Science, reproduction, population and ecosystems
Content Standards: Grades 9–12
Content Standard A: Science as Inquiry
Content Standard C: Life Science, matter, energy, and organization in living systems

Tips

- Keep the Petri dishes in a well-lit area but not direct sunlight. Use gro-lights if bright natural light is not available.
- Pooling class data for Part I of the activity is much more likely to yield the expected growth curves when they are graphed.
- Let your students invent ways to increase the rate of duckweed growth. Anticipate obvious variables and have materials available for use. Light, heat, fertilizer, soil, and aeration are just a few of the likely variables students will suggest.

Materials for *A Population Study* are available from Flinn Scientific, Inc.

Catalog No.	Description
FB1433	Duckweed Population Study—Student Laboratory Kit
LM1133	Lemna (Duckweed), 2 oz
FB0596	Cellophane, Roll, Red
FB0597	Cellophane, Roll, Green
FB0598	Cellophane, Roll, Blue
FB0676	Fertilizer, All-purpose Liquid

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.