[1]307. EFFECTS OF ENVIRONMENTAL FACTORS ON BIOMASS

M. Key

Plant biomass, defined as the quantity of living vegetation in a given area, provides energy upon which herbivores, detritivores, and, indirectly, carnivores depend. Plants are estimated to capture only about 1 percent of the total solar energy striking the earth. Depending upon environmental factors, they may respire 25 to 80 percent of the captured energy, with the rest going to form plant biomass. Only about 5 to 10 percent of energy held in the plant biomass is harvested by herbivores, with detritivores consuming the remainder.

Biomass production in terrestrial plants can be altered by any factor which impinges upon photosynthesis or plant growth. Information in your textbook should help you determine what factors might be important. Some of these factors, and potential methods of investigating them, include:

- Light intensity: plant growth shaded by increasing numbers of gauze layers (may be more precisely quantified using light meter)
- Light quality: grow plants under colored filters
- Temperature: grow plants in temperature-controlled growth chambers
- Nutrient availability: grow with nutrient-deficient solutions (including, but not limited to: N, P, K, and Fe)
- Acidity or alkalinity of growth medium: grow plants in solution or soil of varying pH
- Plant density: control spacing of seeds or plants
- Herbivory: add insects, allow grazing, use scissors

Text References

POH p. 1094, Areas, Biomass of Plants, and Net Primary Production of Earth's Major Vegetation Zones (table); p. 1095, Energy Flow Through Ecosystems; p. 1096, The Major Trophic Levels (table); 1096-1098, Trophic Levels; p.674-676, Plants and Herbivores; p. 679-682, Plant Nutrition

Study Questions

How can grazing increase productivity of plants? How can we determine what nutrients are essential for plant growth? What factors are important in limiting plant growth under natural conditions? Under agricultural conditions?

Purpose

To predict and test the effect of an environmental factor on plant biomass production.

Materials: rye and radish seeds, *Lemna minor* or student-supplied seedlings of other plant species; artificial light; gauze; growth chambers; chemicals for preparation of nutrient solutions

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[1]Advance preparation required. You must consult with your laboratory instructor well in advance to be sure all the supplies you require will be available.

Plant material and growth measurements.

Rye grass (a monocot) and radish (a dicot) germinate in a few days and grow rapidly, making them good candidates for biomass study. Biomass production can be quantified by weighing plants dried overnight at 105º C and/or by measuring changes in plant size over time. You can use other seeds or plants. Nurseries and variety stores carry inexpensive six packs of conveniently small plants of various species.

Another species available in the laboratory is *Lemna minor* (duckweed). This is an aquatic plant small enough to grow in baby food jars. Although *L. minor* is capable of sexual reproduction, it primarily reproduces asexually. Asexual vegetative growth occurs when individual leaves break away from the parent plant to become independent organisms. Under optimal conditions, *L. minor* can double the number of individuals in less than five days. You can monitor the growth of *L. minor* by counting the number of individual leaflets over time.

Experimental design.

Before you set up your experiment, spend some time thinking about your experimental design. Discuss the experiment with your laboratory partners. What factor(s) will you vary? What is the best type of plant to use for your study? How will you measure plant growth? What is (are) the best control(s)? Check with the laboratory instructor concerning the availability of the supplies you will need. *Record you experimental plan and your results on the worksheet.*

Do not be surprised or upset if you encounter difficulties during the course of your experiment. Keep in mind your experimental objective as you solve any problems that arise. Even the best-planned experiment may require mid-course adjustments. Problem-solving, like formulating hypotheses and designing experiments, is a creative process that makes science fun.

Recipes

Lemna medium

1.18 g	$CaNO_3 \cdot 4H_2O$
0.493 g	$MgSO_4 \cdot 7H_2O$
0.509 g	KNO_3
5 mg	ferric citrate
0.136 g	KH_2PO_4

tap water to 1 liter

Additional References

DeBuhr, Larry E. (1991). Using *Lemna* to study geometric population growth. The American Biology Teacher, 53:229.

Dennison, Michael D. (1991). Studies of population ecology using protozoa. BIO150Y: Organisms in Their Environment, Laboratory Manual. Departments of Botany and Zoology, University of Toronto.

Jacklet, Alice. (1992). Population growth of *Lemna*. p.121-128 *In* Laboratory Manual to Accompany Life. Wm. C. Brown, Dubuque, IA.

Pianka, Eric R. (1988). Evolutionary Ecology, 4th edition. Harper & Row, New York.

307. EFFECTS OF ENVIRONMENTAL FACTORS ON BIOMASS (15 PTS+)

Name . Lab day and time ____________________________

PRELAB PREPARATION:

1. What hypothesis are you testing?

2. Write a detailed description of your procedure. There should be enough information so that another student could exactly duplicate your experiment.

3. What do you expect the results to be?

4. Design any data tables, graphs, etc.

RESULTS:

5. Present the results of your experiment.

6. Were your predictions upheld? Cite specific data to support your answer.

7. How firm are your conclusions? What additional research needs to be done to confirm your results?

8. Suggest hypotheses to explain your results. What additional experiments does your work suggest?

9. What are the possible sources of error in your experiment. How would you modify your procedure to obtain more reliable results?