

Plant Ecology
HW – Competing selective forces in the environment
Integration of past material and just so stories

Purpose

Question to be answered in this assignment: How might natural selection lead to the evolution of underwater leaves with a different shape (i.e. phenotype) than above water leaves of the same species?

All organisms live and reproduce in complex environments with multiple stressors or selective pressures. In the context of natural selection and evolution, different stressors may affect survival and/or reproduction in different ways. This means that in a complex environment different phenotypes (e.g. morphologies, anatomies, physiologies, or behaviors) may be selected for in the same environment.

First, you will read and understand a set of facts about a complex environments and some observed plant phenotypes in those environments. You will then formulate a narrative that integrates the given facts, known concepts of natural selection, and how the competing environmental stressors likely result in the evolution of one of several possible phenotypes.

Basics about the assignment

- 1) Brief, but complete, essay that will show me your knowledge of natural selection and evolution, as you apply concepts to example provided.
- 2) Essay must not refer to this assignment text.
- 3) Audience is a sophomore, biology major.
- 4) HW due on CANVAS. Due date and time on CANVAS.
- 5) Worth 15 pts.

Background / Scenario

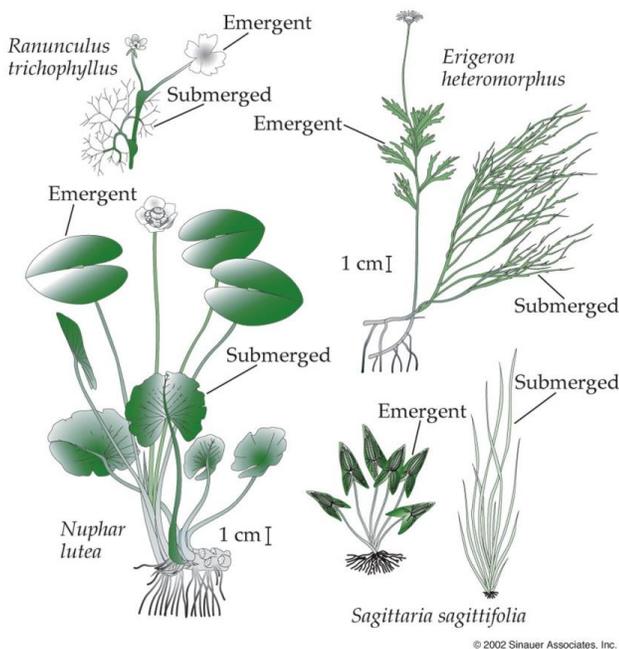


Fig. 1. Four aquatic plant species. Each species grows leaves above the water's surface (i.e. emergent) and leaves below the water's surface (i.e. submerged).

Figure 1 illustrates four emergent, aquatic, plant species. Emergent means that parts of plants grow under the water's surface and other parts emerge from the water and grow above the surface of the water. Leaves of many emergent plant species exhibit different leaf morphologies. This leads to the question you will answer here, "how might natural selection lead to the evolution of underwater leaves with a small, dissected phenotype not a large, non-dissected leaf phenotype?"

These differently shaped leaves have evolved in different environments. But, these leaves, first, have similar needs. Photosynthesis needs light to produce glucose and photosynthesis needs CO₂ to produce

glucose. Here are some facts about differences between light and CO₂ in the air and under water. Each statement is in contrast to above water physics and chemistry:

- Under water, longer wavelengths of light are quickly absorbed by the water particles.
- Under water, CO₂ does not diffuse as quickly as it does in the air. So, slow diffusion rates of CO₂ in the water would limit CO₂ availability in the water.

Here are facts about leaf shape and photosynthesis. Each statement is in contrast to the “opposite” leaf shape AND you may always assume that the opposite is true:

- Larger and wider leaves provide a larger surface area than smaller, thinner leaves (that’s an obvious one), so larger leaves can capture more light.
- Larger and wider leaves have a thicker boundary layer than smaller, thinner leaves (that’s not as obvious. This thicker boundary layer slows the diffusion of CO₂ into the leaf.

What you must EXPLAIN

These are conflicting hypothetical selective pressures on leaf size of submerged leaves of plants. We know from observations that at least in some species submerged leaves are smaller and more dissected. Tell a just-so-story that incorporates all of this information and that would result in the evolution of smaller / more dissected leaves under the water and not larger / less dissected leaves under the water. Note that the comparison I want you to make is about 2 possible shapes of leaves under the water. A high quality just-so-story will

- use descriptions that make clear the role of individuals (they live or die, they are more or less fit) and populations (phenotypic frequencies shift) in natural selection,
- use descriptions that include all of the things (i.e. criteria) that are necessary for natural selection to happen in a population,
- be organized and written without reference to the information in this assignment.

In short, please fully and completely answer the question, “how might natural selection lead to the evolution of underwater leaves with the small, dissected phenotype not the large leaf phenotype?”

Plant Ecology

Rubric – Competing selective forces in the environment

Integration of past material and just so stories

15 points possible

Use √, √-, 0 grading

√ means very good to excellent

√- means fair to good

0 means missing to poor

Broad goal:

- incorporate all of factual information
- show how evolution of narrow leaves would result

Rubric – Competing selective forces in environment	
√, √-, or 0	Content criterion
	incorporates all relevant factual information
	makes clear the role of individuals in natural selection
	makes clear the role of populations in natural selection
	includes all criteria for natural selection in descriptions <ul style="list-style-type: none">• phenotypic variation (not included if given to students)• differences in fitness (not included if given to students)• genetic cause of phenotype (not included if given to students)
	provides reasoned explanation of which leaf type evolves and why that type evolves