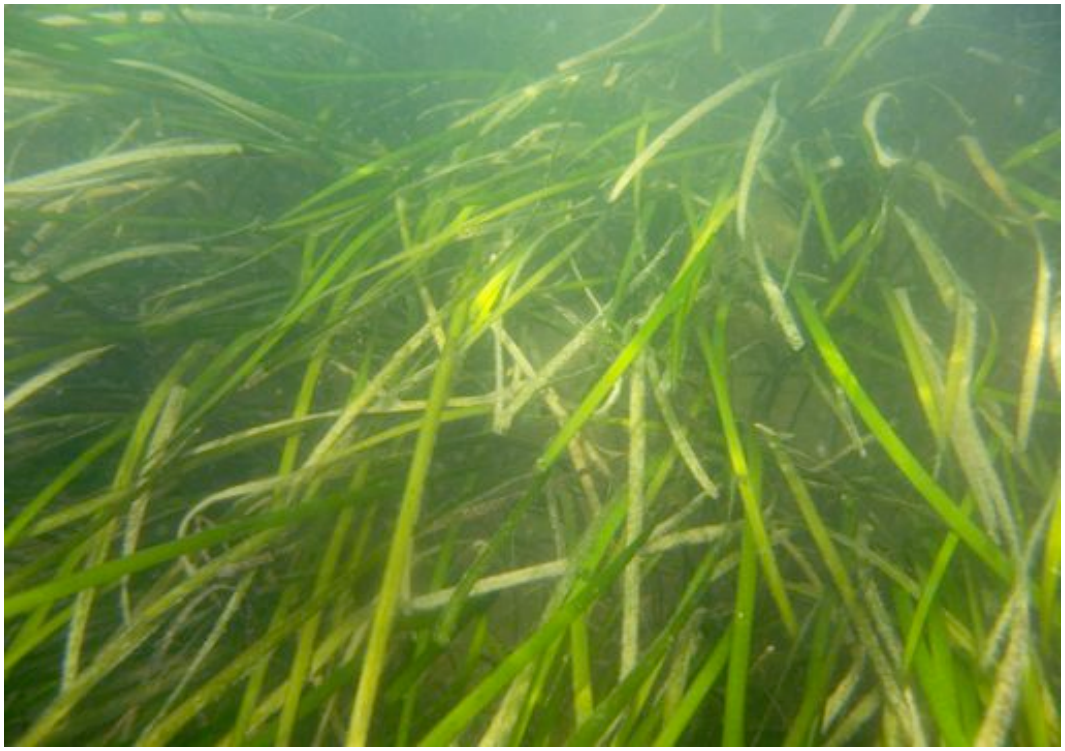
Photosynthesis and Seagrass Ecology

A hands-on science experiment focusing on photosynthesis in aquatic plants of the Chesapeake Bay



Objective

To explore the amount of light required for photosynthesis by an aquatic plant.

National Science Education Standards:

9-12 A. Science as Inquiry

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

9-12 C. Life Science

- Matter, energy, and organization in living systems
- The behavior of organisms

9-12 F. Science in Personal and Social Perspectives

- Environmental quality
- Natural Resources

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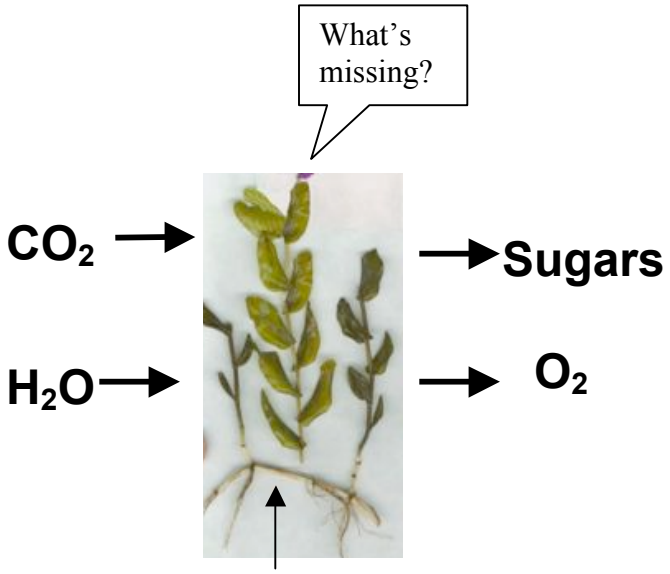
Background

Plants capture light and convert it to chemical energy (food) through a process called photosynthesis. A pigment contained in the plant cells, chlorophyll, captures the light energy and transfers it to a chemical called adenosine tri-phosphate (ATP). This energy is then used by the plant to make sugars and other molecules we commonly call "food". Without this process the only things you would have available to you to eat are salt and water. All other foods originate in one way or another from plants.



Submersed Aquatic Vegetation (SAV) or seagrass is a type of plant that grows completely underwater. In fact, if left out of the water for any length of time, it will dry up and die. Scientists can determine the amount of light required for SAV survival and growth by measuring the amount of oxygen the plant produces under varying light levels. Here we will use the same technique used by scientists to explore the relationship between light and photosynthesis in a species of SAV (*Potamogeton perfoliatus* or redhead grass) found in the mid-salinity waters of the Chesapeake Bay. We will determine the relative rate of photosynthesis by measuring the change in oxygen produced over time, using an oxygen meter.

In clear water light can penetrate deeper into the water, while cloudy water can limit SAV growth by limiting the amount of light reaching these plants growing on the bottom. We will assess optimal habitat conditions for SAV growth and survival by measuring water clarity in two aquatic environments, the Choptank River, and experimental SAV ponds.

Materials

3 BOD bottles per group (one clear, one shaded, one darkened)
2 sets of aquatic plants (seagrasses)
Plastic trays
Oxygen meter with stirring system
Water bath for temperature maintance

Procedure

Students will divide into groups of 7-8 students per group.
Each group will be provided with 3 bottles (see Figure 1 & 2):
1. bottle A is unshaded (100% light),
2. bottle B is shaded 50% of ambient light,
3. bottle C is completely darkened (0% light),
One group will be the "control" group.

Light Bottle Shade Bottle Dark Bottle

Figure 1. Experimental bottles.

1. *Determining the Initial oxygen concentration*

1. Fill each labeled bottle with filtered river water to overflowing from bucket provided.
2. a. Plant Groups: Place three 10 cm. segments of SAV plants in bottles.
b. "Control" Group: Fill bottles with water. Do NOT add plant to bottle.
3. Place a stir bar into each bottle.
4. Place bottle on stir plate and set stirring speed so that the water is significantly stirred.
5. Immediately have the instructor measure the initial oxygen concentration of all bottles using the oxygen meter.
6. Record your oxygen readings (mg/l) under the Initial O_2 column on the data sheet.

Figure 2. Bottle set up for photosynthesis experiment

7. Tightly cap your bottles and place in a water bath for at least 1 hour (note the time).
8. For shaded bottle (B), add shade cover before placing bottle in water bath.

2. *Determining the Final oxygen concentration*

9. After an incubation period of at least one hour, retrieve your bottles from the water bath and note the time.
10. Have the instructor measure the oxygen concentration in each of the bottles.
11. Record the oxygen readings (mg/l) in the Final O_2 column of the data sheet.

Results: Data Analysis

Determining Photosynthesis in relation to light level

12. Calculate the change in oxygen as by subtracting the Initial O_2 from the Final O_2.
13. Obtain data from the control group and record readings from the "blank" bottles on your data sheet.
13. Use the data from the control bottles to correct your readings by subtracting the change in oxygen in the blank bottles from the corresponding readings in all three experimental bottles.

14. Each group is considered a replicate. On your data sheet, average the data from all four groups for each light level to determine the average oxygen change.
15. Graph your results to show the relationship between light and photosynthesis as measured by the change in oxygen.

Example:

Bottle #	**Initial O_2**	**Final O_2**	**O_2 Change**	**Correction for "Blank" O_2 Change – blank**
A light	**7.0**	**9.0**	**+2.0**	**+2.0 - (+0.1) = +1.9**
Blank light	7.0	7.1	+0.1	
B shade	**7.0**	**8.0**	**+1.0**	**+1.0 - (+0.1) = +0.9**
Blank shade	7.0	7.1	+0.1	
C dark	**7.0**	**5.0**	**- 2.0**	**- 2.0 - (- 0.1) = - 1.9**

Photosynthesis Data Sheet

Date: _____ **Team Name:** _____

Oxygen Reading (mg O_2/l)

Record your initial and final oxygen readings from your bottles here. Once you have recorded the final readings, you can calculate the change in oxygen. Make sure to indicate with a – if your oxygen change is negative (if the oxygen concentration decreased).

Initial Time:_____ **Final Time:**_____

Bottle #	**Initial O_2**	**Final O_2**	**O_2 Change** (Final O_2 – Initial O_2)
Plant Light	_____	_____	_____
Plant Shade	_____	_____	_____
Plant Dark	_____	_____	_____
Control Light	_____	_____	_____
Control Shade	_____	_____	_____
Control Dark	_____	_____	_____

Correction for Control

In this section, subtract the change in oxygen in your control bottles from the change in oxygen in your bottles containing plants. Remember that subtracting a negative is adding a positive.

	O_2 Change	–	**Control O_2 Change**	=	**Final O_2 Change**
Light	_____	-	_____	=	_____
Shade	_____	-	_____	=	_____
Dark	_____	-	_____	=	_____

Data From Other Teams: Final O_2 Change (mg O_2/l)

Copy the Final O_2 Change data from the other teams and then calculate the Average O_2 Change.

	Final O_2 Change		
Team Name	**Light**	**Shade**	**Dark**
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
Average O_2 Change	_____	_____	_____

Water Quality Data Sheet

A. Weather Conditions - *POND*

Time of Observation: _____

Cloud Cover and Current Weather:
(Check (√) one)

Clear ____ **Partly Cloudy** ____ **Mostly Cloudy** ___ **Overcast** ____ **Rain** ____ **Fog** ____

Recent Weather Conditions: _____
(e.g. recent rain storm or high winds)

Wind Direction: N – NE – E – SE – S – SW – W – NW
(Circle one)

Wind Speed: _____ mph **Air Temperature:** _____ ˚C/˚F

A. Weather Conditions - *RIVER*

Time of Observation: _____

Cloud Cover and Current Weather:
(Check (√) one)

Clear ____ **Partly Cloudy** ____ **Mostly Cloudy** ___ **Overcast** ____ **Rain** ____ **Fog** ____

Recent Weather Conditions: _____
(e.g. recent rain storm or high winds)

Wind Direction: **N – NE – E – SE – S – SW – W – NW**
(Circle one)

Wind Speed: _____ mph **Air Temperature:** _____ ˚C/˚F

Surface Conditions:
(Check (√) one)

Calm _____ **Ripple** _____ **Light Chop** _____ **Whitecaps** _____

B. Water Light Readings (PAR)

POND Measurements			*RIVER Measurements*
	In Grass	**Outside**	
Surface	_____	_____	**Surface**_____
Bottom	_____	_____	**25 cm** _____
			50 cm _____
			75 cm _____
			100 cm _____

C. Water Clarity (Secchi Depth (cm))

	Secchi Depth Pond	**Secchi Depth** River	**Water Depth** Pond / River
1	_____	_____	_____ / _____
2	_____	_____	
3	_____	_____	
4	_____	_____	

Water Clarity (TSS)

Record Color of Water: _____

Record Color of Filter: _____

Save filter for comparison:

Paste filter here: ⇨

Questions and Conclusions

1. What were the "control" and variables for this experiment?

2. How do you know photosynthesis was occurring?

3. What effect did shading have on the photosynthesis of SAV? Explain your answer.

4. Was photosynthesis occurring in the dark bottles? Explain your answer.

5. What are the physical conditions needed for SAV growth?

6. Formulate a conclusion for your experiment based on the data obtained.